LOCKHEED MARTIN

LOCKHEED MARTIN MISSILES & SPACE
VALLEY FORGE OPERATIONS
P.O. BOX 8555
PHILADELPHIA, PA 19101–8555

EOS–AM SPACECRAFT PROGRAM GENERAL DOCUMENT TRANSMITTAL

DATE: 10 August 1998 **EOS–EDCN–** 1031

TITLE: Transmittal of Excerpts from "Test Report for EOS–AM1 Spacecraft Thermal Balance Test," VRD–130, 29 July 1998

AUTHOR: C. Wilda

SENT BY: C. Wilda **NO. COPIES:** 35

EXTERNAL DISTRIBUTION:
See Attached

Outgoing GFSC Correspondence
OGC NO: 98-0242

Transmit Date: 8-12-98

INTERNAL DISTRIBUTION:

EOS Data Management Center (2) – B100, M3037

M. Maheu	B100, 3–4800
W. Merriman	B100, 3–4800
C. Wilda	B100, M3217

REMARKS:

EOS Form 023–02/96

LOCKHEED MARTIN

EXPORT LICENSING AND CONTROLS DOCUMENT APPROVAL RECORD

LOG # _____

DATE 10 August 1998

Contract Applicable NAS5–32500 (Number) EOS–AM (Program Name)

Document Identification/Description:

EOS–EDCN–1031 Transmittal of Excerpts from "Test Report for EOS–AM1 Spacecraft Thermal Balance Test," VRD–130, 29 July 1998

Claire Wilda

Signature (Initiator)**

Approval for Release to: (Include: Name, Address & Country)

G. Bailak, J. Drummond: University of Toronto

R. Colley, D. Peterson: Canadian Space Agency

R, Deschambault, D. Caldwell, T. Girard, J. Hackett, D. Henry, M. Maheu: COM DEV CANADA

Each Signee to Circle Applicable Choice

1 2 (3) 4 5 6 7 — Technical Review & Approval (Program Manager, Deputy Program Manager, Engineering Program Manager) — Date 8/10/98

1 2 (3) 4 5 6 7 — Contracts/Subcontract Manager — Date 8/10/98

1 2 (3) 4 5 6 7 — Export–Control Manager — Date 8/10/98

License or Exemption Number: _____

1: Information in the Public Domain ITAR, Para. 120.11
2: In accordance with ITAR Para. 125.4 – General Exemptions
3: In accordance with ITAR Para. 126.5 – Canadian Exemption
4: In accordance with Department of State, Office of Defense Trade Controls Authorized License or Agreement
5: In accordance with Department of Commerce validated license or general license
6: Does not contain Technical Information as defined in ITAR
7: New License Required
** Responsible for obtaining proper approvals prior to export.

Rev. 2/22/94

LOCKHEED MARTIN

LOCKHEED MARTIN MISSILES & SPACE
VALLEY FORGE OPERATIONS
P. O. Box 8555
Philadelphia, PA 19101

10 August 1998 EOS–EDCN–1031

To: Distribution
From: C. Wilda
Subject: Transmittal of Excerpts from "Test Report for EOS–AM1 Spacecraft Thermal Balance Test," VRD–130, 29 July 1998

Excerpts from "Test Report for EOS–AM1 Spacecraft Thermal Balance Test," VRD–130, 29 July 1998, and associated presentation announcement are provided for your information.

The LMMS point of contact is C. Wilda, who can be reached on (610) 354–1875.

Attachment

MODIS/MOPITT

The attached Thermal Balance Report contains comparisons of the analytically predicted test temperatures with the test temperature results. It also compares pre-test power estimates and measurements with measured test powers (currents). It is important that the thermal designers review appropriate sections of the report and be satisfied with the comparisons because these models will be used to make the LMMS launch and flight predictions.

On August 27, 1998 LMMS will provide a presentation and discussion of the report at the GSFC, Building 16W, Room N76/N80, beginning at 9:00 am.

Archie Fitzkee, 301-286-3725

Please contact Tom Anderson at 301-286-1189 with any questions.

Post-it™ brand fax transmittal memo 7671	# of pages ▸ 1
To DOUG CHALMERS	From ARCHIE FITZKEE
Co. LMMS	Co. GSFC
Dept. X 1869	Phone # X 3725
Fax # 8-610-354-2201	Fax # 301-286-3725

RELEVANT SECTIONS
ONLY FOR INSTRUMENTS

- [ ] ASTER
- [ ] CERES
- [ ] MISR
- [x] MODIS
- [x] MOPITT

Test Report For EOS–AM1 Spacecraft Thermal Balance Test (VRD–130)

Prepared under:
Contract NAS5–32500
NASA Goddard Space Flight Center
Greenbelt, Maryland 20771

Prepared by:
Lockheed Martin Corporation
Lockheed Martin Missiles & Space
Valley Forge Operations
P.O. Box 8555
Philadelphia, Pennsylvania 19101

(This page intentionally left blank.)

TABLE OF CONTENTS

SECTION / PARAGRAPH	TITLE	PAGE
1	SCOPE	5
1.1	Test Item	5
1.2	TP Title	5
2	APPLICABLE DOCUMENTS	8
2.1	LMMS Documents	8
2.2	LMMS Test Procedures	8
2.3	LMMS Memos	8
2.3	Other Memos/Correspondance	8
2.4	Documentation Source	9
3	TB TEST REPORT	10
	ATTACHMENTS 1–4	

DCC071594

LIST OF FIGURES

FIGURE	TITLE	PAGE
Figure 1.	Verification Report Form	8

1 SCOPE

This report documents the results of the Earth Observing System (EOS) AM1 Spacecraft Thermal Balance Test, including details on the correlation of the S/C Thermal Mathematical Model (TMM) and performance of the Thermal Control Subsystem (TCS). See Figure 1 for the Verification Report Form.

1.1 Test Item

The test item was the EOS–AM1 Spacecraft manufactured by Lockheed Martin Missiles & Space, Valley Forge Operations. Part number 20008500G1. Serial number 27040X.

1.2 TP Title

This test report covers the set of EOS–AM1 Thermal Vacuum test procedures of TP01–TV20008500, TP02–TV20008500, and TP03–TV20008500. These procedures primarily spanned the time from January 30 through March 19, 1998 and were conducted in Valley Forge Building 300. The Thermal Balance and TCS Performance testing was covered mainly during the period from February 7th through the 13th.

PERFORMANCE VERIFICATION DOCUMENTATION
Page 1 of 2

EOS–AM SPACECRAFT VERIFICATION REPORT

ITEM: EOS–AM1 Spacecraft
MANUFACTURER: LMMS VF Operation
PART NO.: 20008500G1 SERIAL NO.: 27040X
LEVEL OF ASSEMBLY: ☐ COMPONENT ☐ EM ☐ MAJOR ASSY. ☐ HOUSEKEEPING BUS ☒ SPACECRAFT
TYPE OF HARDWARE: ☐ QTM ☒ PROTOFLIGHT ☐ FLIGHT ☐ SPARE ☐ ENGINEERING

REQUIREMENT(S) VERIFIED: See Section 3
(State requirement(s) verified and identify source)

VERIFICATION METHOD: ☒ ANALYSIS ☐ INSPECTION ☐ DEMONSTRATION ☒ TEST
TYPE TEST:

- ☐ COMPREHENSIVE PERFORMANCE
- ☐ MODAL SURVEY
- ☐ STRUCTURAL LOADS
- ☐ SINE VIBRATION
- ☐ RANDOM VIBRATION
- ☐ ACOUSTIC
- ☐ ELECTROMAGNETIC COMPATIBILITY
- ☐ ALIGNMENT
- ☐ FUNCTIONAL PERFORMANCE @ AMBIENT
- ☐ FUNCTIONAL PERFORMANCE @ TEMP.
- ☐ MECHANICAL SHOCK
- ☒ THERMAL BALANCE
- ☐ THERMAL VACUUM
- ☐ LEAKAGE
- ☐ MASS PROPERTIES
- ☐ TEMPERATURE CYCLE
- ☐ INTERFACE VERIFICATION
- ☐ OTHER (explain) _____

VERIFICATION SUMMARY: See Section 3
(Summarize results of verification)

Figure 1. Verification Report Form

PERFORMANCE VERIFICATION DOCUMENTATION
Page 2 of 2

VERIFICATION REPORT (Continued)

VERIFICATION PROCEDURE NO. See Section 1.2 REV. _____ DATE 7/29/98

☐ INITIAL TEST
☐ RETEST (☐ PARTIAL OR ☐ FULL; INITIAL TEST START DATE)

APPLICABLE TEST PLAN: PN–20005400
FACILITY DESCRIPTION: Building 300, East T/V Chamber
LOCATION: LMMS–VF
TEST LOG REFERENCE: Spacecraft Test Conductors Log Book & TCS log book

COMMENTS: _____
SIGNATURE: _____

DESIGN OR SYSTEMS ENGINEER: [signature] DATE 7/30/98
TEST DIRECTOR OR TEST ENGINEER: Stephen O. Cogan DATE 7/30/98
QUALITY ASSURANCE REPRESENTATIVE: [signature] for E. Hawely DATE 7/30/98

Date (add time for thermal tests)	Ambient Temp/ Humidity (°C, RH)	Note beginning and end of actual activity, deviations from the planned procedure, and discrepancies in test performance.	Failure Report Number and Date (if applicable)
		See Section 3	
		(use additional paper as required)	

The activities covered by these reports include analyses, tests and measurements performed for the purpose of verifying the flightworthiness of hardware at the applicable level of assembly.

Material necessary to clarify this report including copies of Design Notes or test/inspection data shall be attached. Test logs and data should be retained by those responsible for the test item in accordance with the provisions of the Performance Assurance Implementation Plan.

This report does not replace the need for maintaining complete logs, records, etc.; it is intended to document the implementation of the verification program and to provide a minimum amount of information as to the performance of the test item.

Figure 1. Verification Report Form (Continued)

2 APPLICABLE DOCUMENTS

The documents referenced herein form a part of this report as specified. In the event of conflict between this report and the referenced documents, the referenced documents shall govern.

2.1 LMMS Documents

PN20005404	Verification Plan EOS–AM1 Spacecraft (VRD–100)
PS20005404	Verification Specification EOS–AM1 Spacecraft (VRD–100)
PS20008549	Performance Specification, Thermal Control Subsystem EOS–AM1 Spacecraft
20048678	Requirements and Implementation Plan, Heat Pipe Leveling

2.2 LMMS Test Procedures

TP01–TV20008500	Test Procedure, Thermal Vacuum Set–up for the EOS–AM1 Spacecraft (VRD–140)
TP02–TV20008500	Test Procedure, Thermal Vacuum for the EOS–AM1 Spacecraft (VRD–140)
TP02–TV20008500	Test Procedure, Thermal Vacuum Tear–Down for the EOS–AM1 Spacecraft (VRD–140)
TP–HV20008500	Test PRocedure, EOS–AM1 Heater Verification

2.3 LMMS Memos

EOS–PWR–556A	HCE5A Battery Cell Temperature Anomaly PR–2967 and PR–3084, ADR–178143
EOS–TH–898	HCE2A Telemetry Out of Tolerance PR–2688, PR–2725, PR–2891, and PR–2933
EOS–TH–893	Propulsion Module Propellant Lines

2.4 Other Memos/Correspondance

2103–009/WCP–001	SWALES memo re Thermal–Optical Measurements of EOS–AM Flight Parts
JAROS Letter July 23, 1998	Comments on the Results from TV Testing

2.5 Documentation Source

Source: Lockheed Martin Missiles & Space
Valley Forge Operations
P. O. Box 8555
Philadelphia, PA 19101

3 TB TEST REPORT

See Attached Vugrapph presentation package.

(This page intentionally left blank.)

EOS–AM Spacecraft

Thermal Balance Test

Thermal Model Correlation/Analysis & Thermal Control System Performance Results

Contents

LOCKHEED MARTIN

Topic	Page #
Introduction	3
TB Test Overview	5
Post–Test Activities	21
Thermal Model Correlation Results	
– Spacecraft Components	25
– Instruments	80
TCS Hardware Performance Review	110
Conclusions/Recommendations	138

Introduction

- The EOS–AM S/C Thermal Vacuum/Thermal Balance Test (TV/TB) was performed in the Valley Forge 39' West TV Chamber from February 1st 1998 to March 17th 1998.
- The goals of the test were basically:
  - Perform comprehensive S/C systems testing in vacuum over worst case hot and cold temperatures
  - Perform Thermal Balance Testing of the S/C to allow the correlation of the S/C Thermal Mathematical Model (TMM)
  - Complete component/system thermal cycles (4)
- This Vu–graph presentation covers the Thermal Balance/TMM correlation part of the test as well as the evaluation of the Thermal Control System (TCS) Performance testing.
- Serious planning for this test started over 18 months prior to pump down, and with the help of frequent and regular test team meetings resulted in one of the most successful protoflight S/C tests ever performed at a LMMS facility.
- For the test, the EOS–AM S/C, without the Solar Array and HGA, but otherwise configured for flight, was mounted horizontally in the chamber. Spatial environments were simulated on all sides using a variety of methods which included, chamber LN2 walls, calrod heaters, brine–chilled cold plates, and plates with resistance heaters. Over 60 power supplies were used for Calrod and heater control.
- The flight temperature telemetry was supplemented by almost 600 T/Cs hooked up to an RTM–driven data system. Data management of this huge volume of information was facilitated by the addition of 4 dedicated NASA PC's.
- A thermal test team from NASA, LMMS, SWALES and J&T provided round–the–clock support , ensuring an incident–free & successful thermal test.

Introduction

TB Test Overview

Post–Test Activities

Thermal Model Correlation Results

TCS Hardware Performance Review

Conclusions/Recommendations

TB Test Overview
S/C and Chamber Layout

LOCKHEED MARTIN

- Test was conducted in Lockheed Martin's Valley Forge West 39' thermal vacuum chamber with S/C mounted on modified UARS METS fixture.
  - Horizontal "Instruments down" orientation
  - Twenty–three thermal control "zones" located around S/C allowed high resolution in reaching different qualification temperature levels.
    - – Total of 64 150Vdc/13 amp power supplies located outside chamber ensured accurate thermal zone & guard heater control.
  - Velocity direction was chamber North.
- All chamber LN_2 shrouds actively cooled throughout test.
- Tilt sensors (2) located on S/C to aid levelling operations (20048678)
- Externally controlled jacks available for adjusting S/C to ensure 1g heat pipe operation.
- Four TQCMs and two CQCMs to monitor outgassing levels.
- Zéro–Q guard heaters mounted on harnesses and critical MGSE equipment
- Photographs were taken during set–up in the chamber and post–test and are available on file at LMMS

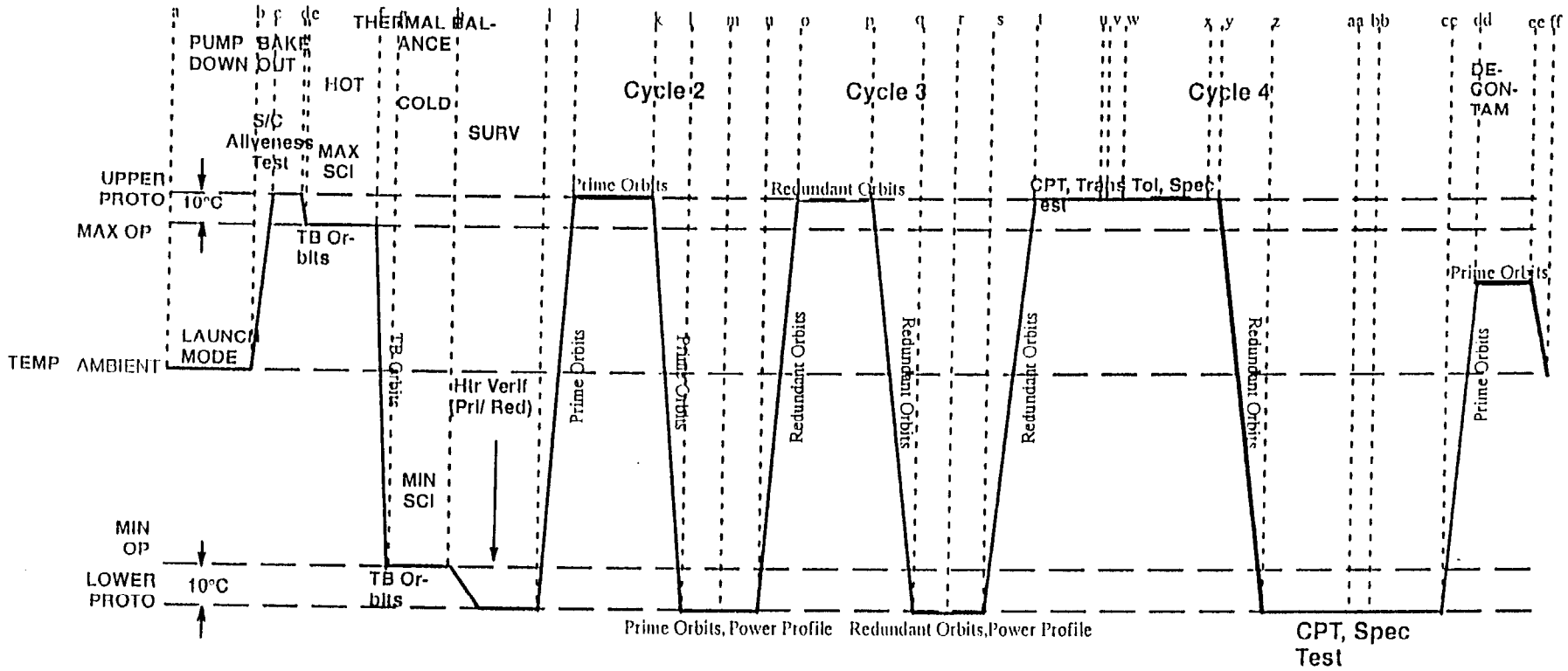
TB Test Overview
Test Configuration

LOCKHEED MARTIN

- Test set–up performed via TP01–TV20008500
- Major differences between Test Article and flight configuration include:
  - Solar Array not installed.
  - High Gain Antenna not installed, but was elsewhere in chamber with separate thermal control zones for reaching qualification temperatures.
  - Separation devices (NEAs) not mounted
  - ESH target mounted on ESHs
- Test performed via TP02–TV20008500.
- Hot and Cold thermal balance plateaus were designed to simulate the worst case expected variations in orbital environmental conditions. S/C simulated normal on–orbit Science mode continuously during both plateaus.
- Instruments operated in Science mode to allow use of GSFC delivered RTM's in correlation analysis.
  - Santa Barbara provided MODIS LN_2 and GHe targets for cryo–cooler sinks.
- Heater Verification plateau verified heater sizing & duty cycle in simulated worst case BOL environment (TP–HV20008500).
  - S/C operated in SAFE mode.
- Thermal model derived from latest S/C model (V6) used in last analysis.
  - Radiator areas derived from detailed thermal models.
  - Granularity added pre–test to match thermocouple/TSA locations.
  - Component dissipations based on pre–test IPTL survey.
  - TIR/MODIS MLI tent TRASYS correspondence error has been corrected post–TV.

TB Test Overview
Test Profile

LOCKHEED MARTIN



Event Interval	Description	Event Interval	Description	Event Interval	Description
a–b	Pumpdown	k–l	Cool to Cold #2	u–v	Pri Trans Tol (Hot #4)
b–c	Warm to Bakeout	l–m	Prime Orbs (Cold #2)	v–w	Spec Tests (Hot #4)
c–d	Bakeout (Aliveness)	m–n	Pwr Profile (Cold #2)	w–x	Red CPT (Hot #4)
d–e	Cool to Hot TB	n–o	Warm to Hot #3	x–y	Red Trans Tol (Hot #4)
e–f	Hot Thermal Bal	o–p	Red Orbs (Hot #3)	y–z	Cool to Cold #4
f–g	Cool to Cold TB	p–q	Cool to Cold #3	z–aa	Prime CPT (Cold #4)
g–h	Cold TB	q–r	Red Orbs (Cold #3)	aa–bb	Spec Tests (Cold #4)
h–i	Heater Verification	r–s	Pwr Profile (Cold #3)	bb–cc	Red CPT (Cold #4)
i–j	Warm to Hot #2	s–t	Warm to Hot #4	cc–dd	Warm to Decontam
j–k	Prime Orbs (Hot #2)	t–u	Prime CPT (Hot #4)	dd–ff	Decontam & Ventback

TB Test Overview
Critical Test Phases & Completion Times

LOCKHEED MARTIN

- For future reference in the body of this report, the critical test phases and approximate completion (date and time) are shown below:

TEST PHASE	COMPLETION			
	LOCAL		GMT	
	DATE	TIME	DATE	TIME
START PUMP DOWN	1-Feb	11:30	1-Feb	16:30
CHAMBER PURGE #3	2-Feb	03:19	2-Feb	08:19
BAKE-OUT	4-Feb	21:35	5-Feb	02:35
HOT TB #1	7-Feb	23:35	8-Feb	04:35
HOT TB #2	8-Feb	07:30	8-Feb	12:30
COLD TB	9-Feb	23:35	10-Feb	04:35
HTR VERIFICATION	12-Feb	00:45	12-Feb	05:45
HOT CYCLE #2	13-Feb	16:20	13-Feb	21:20
COLD CYCLE #2	14-Feb	23:35	15-Feb	04:35
HOT CYCLE #3	16-Feb	11:55	16-Feb	16:55
COLD CYCLE #3	18-Feb	03:30	18-Feb	08:30
HOT CYCLE #4	4-Mar	14:57	4-Mar	19:57
COLD CYCLE #4	14-Mar	18:00	14-Mar	23:00
DECONTAM	16-Mar	15:31	16-Mar	20:31
CHAMBER @ AMB	17-Mar	10:28	17-Mar	15:28

- Hot Thermal Balance used in correlation: 2/8/98 @ 12:30GMT
- Cold Thermal Balance used in correlation: 2/10/98 @ 04:35GMT
- Htr Verification Test completed: 2/12//98 @ 05:45GMT

TB Test Overview
Thermal Control Instrumentation

LOCKHEED MARTIN

- Approximately 600 T/Cs were utilized to monitor S/C, S/C GSE and environmental temperatures. At the end of the test 15 registered as open circuit, and subsequently another 10 were assigned as "questionable" due to inexplicable temperatures.
- The EOS AM S/C "Test Article" was instrumented with approximately 440 TC's (installed during I&T assembly phase).
- Flight telemetry sensors also used to provide correlation data.
  - TC's located to verify heater control setpoints and telemetry sensors.
  - Correlation between TCs and flight sensors discussed later.
- At least two TCs per zone used for feedback and manual control of cal rod arrays.
- T/Cs on METS and other support structures, Chamber Walls, Targets, and auxiliary cold plates.
- Two inclinometers mounted on S/C to measure levelness before and after transition to cold wall. Each inclinometer provided T/C and heater to maintain inclinometer near ambient temperatures.
- Heaters and T/Cs mounted on externally controlled jacks.
- Heaters and T/Cs mounted on four TQCMs and two CQCMs.
- Guard heaters and TCs used mounting interfaces to minimize conductive heat leaks thru METS and HGA mounting structure.
- Guard heaters and TCs used on harnesses to minimize conductive heat leaks.
- Hard and soft copies of all T/C data is on file at LMMS. Power supply voltage settings throughout the test are part of TP02–ENV20008500.

TB Test Overview
Thermal Control Zones

LOCKHEED MARTIN

- Temperature Goals based on equivalent sink of bounding on–orbit environmental fluxes.
  - +/–Y, –X, –Z used tubular ceramic heaters (cal rods), which provide calculated incident fluxes on S/C surfaces, with minimal blockage of view to cold shroud.
    - – Controlled using Equivalent Sink Detectors (ESDs)
    - – CSP and TIR required local +Y Freon plates due to blockage of view to cold wall by METS
  - +Z (Earth) sink controlled using combination of flat Freon (Earth) plate with 19 vertical black painted aluminum plates (facing S/C) and Kapton heaters on side facing chamber wall.
  - +X sink controlled using vertical black painted aluminum plates (mounted on shroud facing S/C) and Kapton heaters on side facing chamber wall.
- All surfaces painted black for high emissivity.
- Each cal rod array was modelled separately in TRASYS as flat surfaces with 0.99 emittance.
- Each +Z and +Y Freon plate and +Z heater plate was modelled separately as black painted surfaces (ε=0.95).
- All zones modelled in SINDA as boundary nodes held at temperature indicated by ESD data from each balance plateau.
- Conductive interface to METS not modelled since guard heaters worked extremely well to eliminate these losses.
- Excellent zone temperature stability achieved throughout Thermal Balance Test Phases (see following pages)

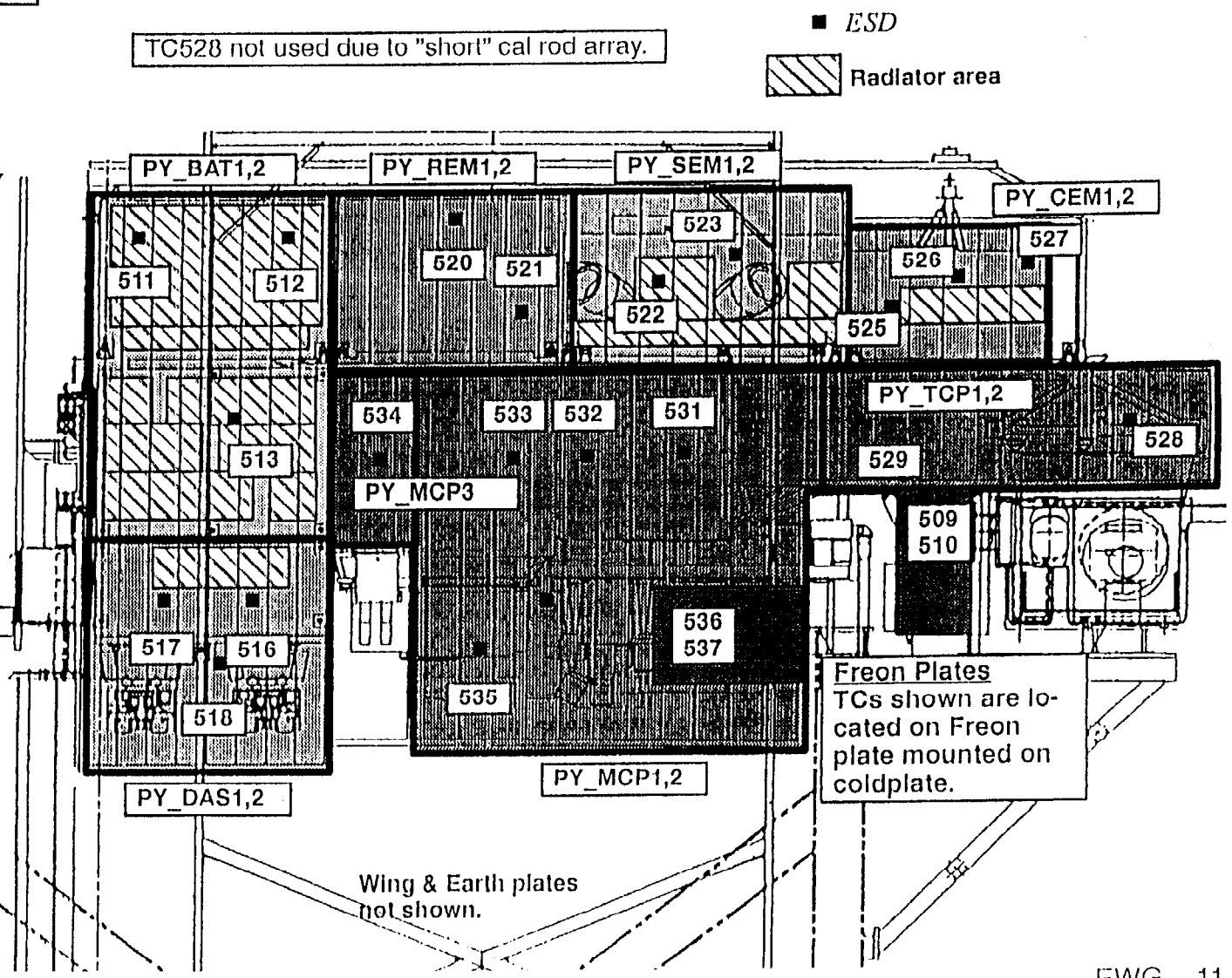
High resolution in achieving desired temperatures.

TB Test Overview
+Y Thermal Control Zone

LOCKHEED MARTIN

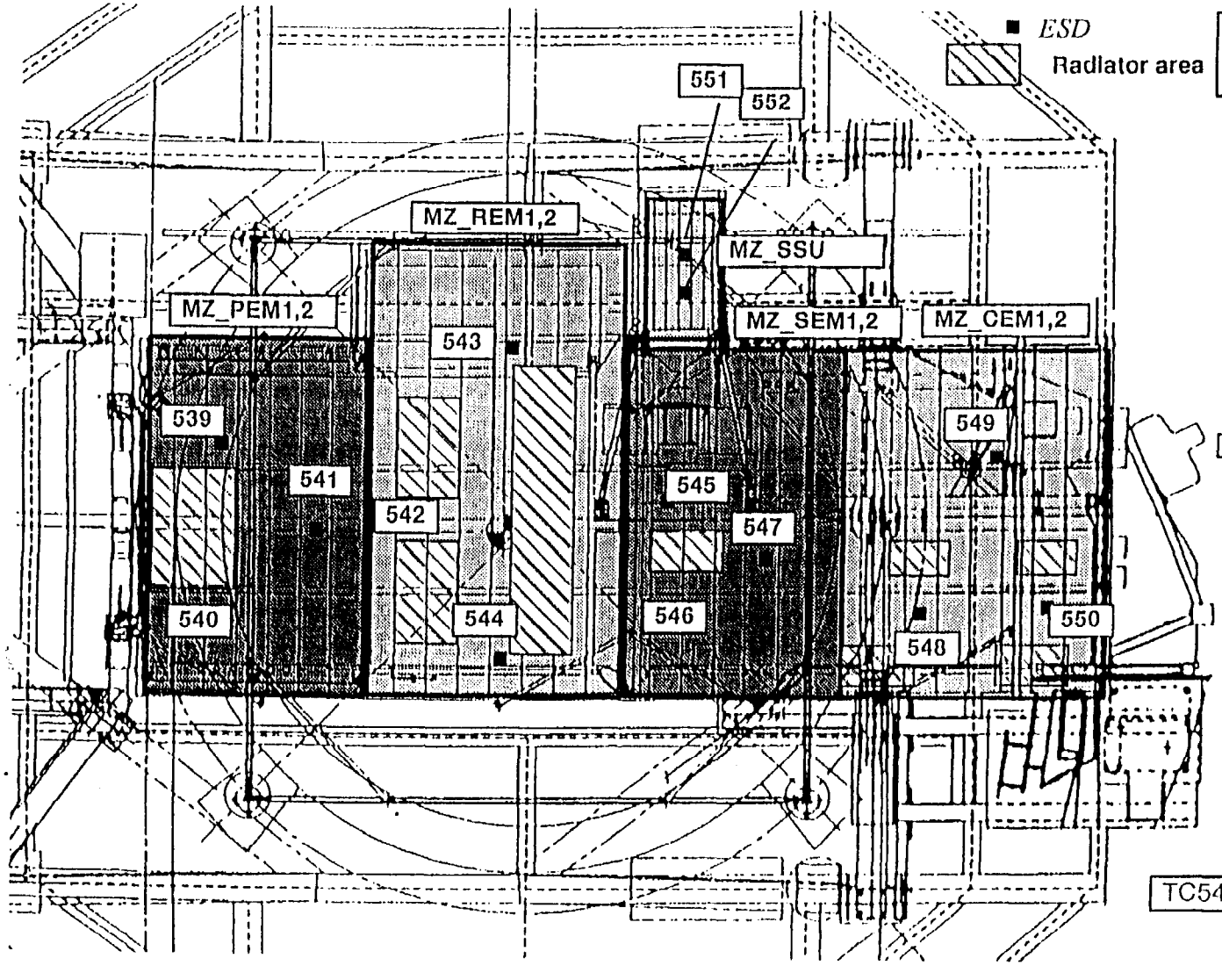
Goal:	–90	–90	–97
TC #	HOT1	HOT2	COLD
509	–78.8	–78.8	–78.9
510	–78.7	–78.8	–78.8
511	–36.1	–27.5	–92.8
512	–58.2	–50.6	–105.7
513	–44.1	–36.8	–92.7
516	–85.4	–85.4	–91.8
517	–84.3	–84.0	–90.9
518	–83.0	–82.8	–88.4
520	–83.3	–83.1	–90.1
521	–86.8	–86.6	–94.0
522	–81.1	–81.1	–88.2
523	–86.9	–86.8	–93.7
525	–84.6	–84.5	–90.4
526	–86.9	–86.8	–93.4
527	–82.1	–82.0	–87.6
528	–113.6	–113.8	–93.0
529	–88.7	–88.5	–75.8
531	–86.9	–86.8	–91.9
532	–83.0	–82.9	–89.4
533	–81.9	–81.7	–88.9
535	–87.9	–88.0	–93.4
534	–83.5	–83.1	–89.1
536	–78.6	–78.6	–78.8
537	–78.8	–78.9	–79.1

TC528 not used due to "short" cal rod array.



TB Test Overview
–Z Thermal Control Zone

LOCKHEED MARTIN



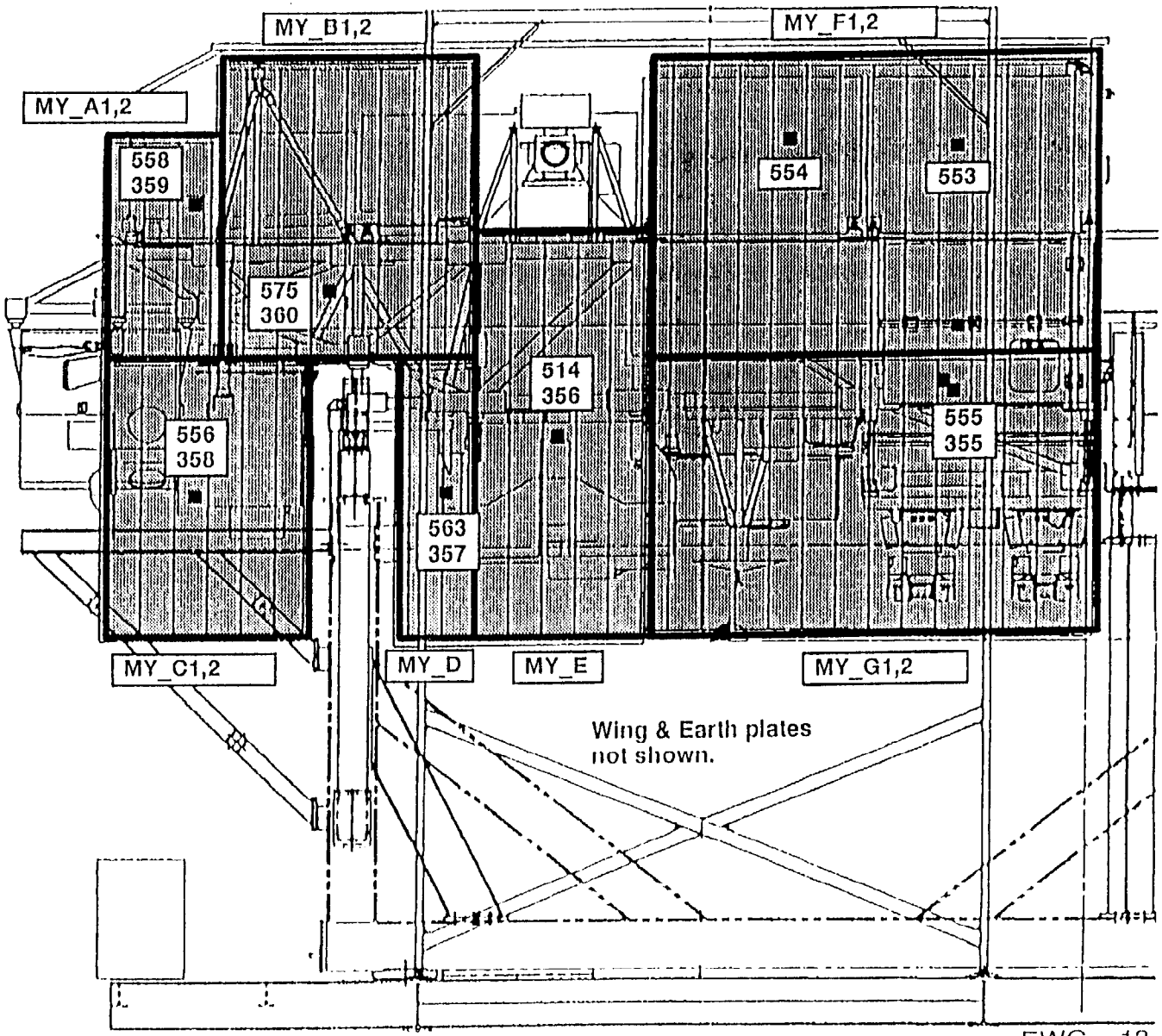
Goal:	–56	–56	–103
(change)	–25	–25	–40
(SEM)	–15	–15	–30
TC #	HOT1	HOT	COLD
539	–25.9	–26.2	–43.1
540	–27.8	–27.9	–46.2
541	–24.8	–25.0	–42.5
542	–16.6	–16.6	–36.6
543	–26.4	–26.7	–40.6
544	–36.2	–36.2	–54.1
545	–24.2	–24.4	–41.0
546	–17.7	–17.8	–37.2
547	–12.5	–12.6	–32.7
548	–3.6	–3.6	–21.6
549	–25.6	–25.7	–42.1
550	–32.2	–32.2	–47.5
551	–34.4	–34.6	–72.3
552	–51.3	–51.5	–86.5

TC548 not used due to large delta

TB Test Overview
–Y Thermal Control Zone

LOCKHEED MARTIN

Goal:	–22	–22	0
TC #	HOT1	HOT2	COLD
558	–24.3	–24.3	0.3
359	–23.5	–23.5	1.1
575	–18.2	–18.3	0.0
360	–17.6	–17.6	0.8
556	–20.3	–20.3	–0.1
358	–19.7	–19.8	0.4
563	–21.0	–21.0	2.0
357	–22.6	–22.6	0.3
514	–19.7	–19.7	1.0
356	–20.7	–20.7	–0.2
553	–19.2	–19.2	0.6
554	–17.4	–17.4	1.5
555	–25.5	–25.5	2.0
355	–26.9	–27.0	0.4

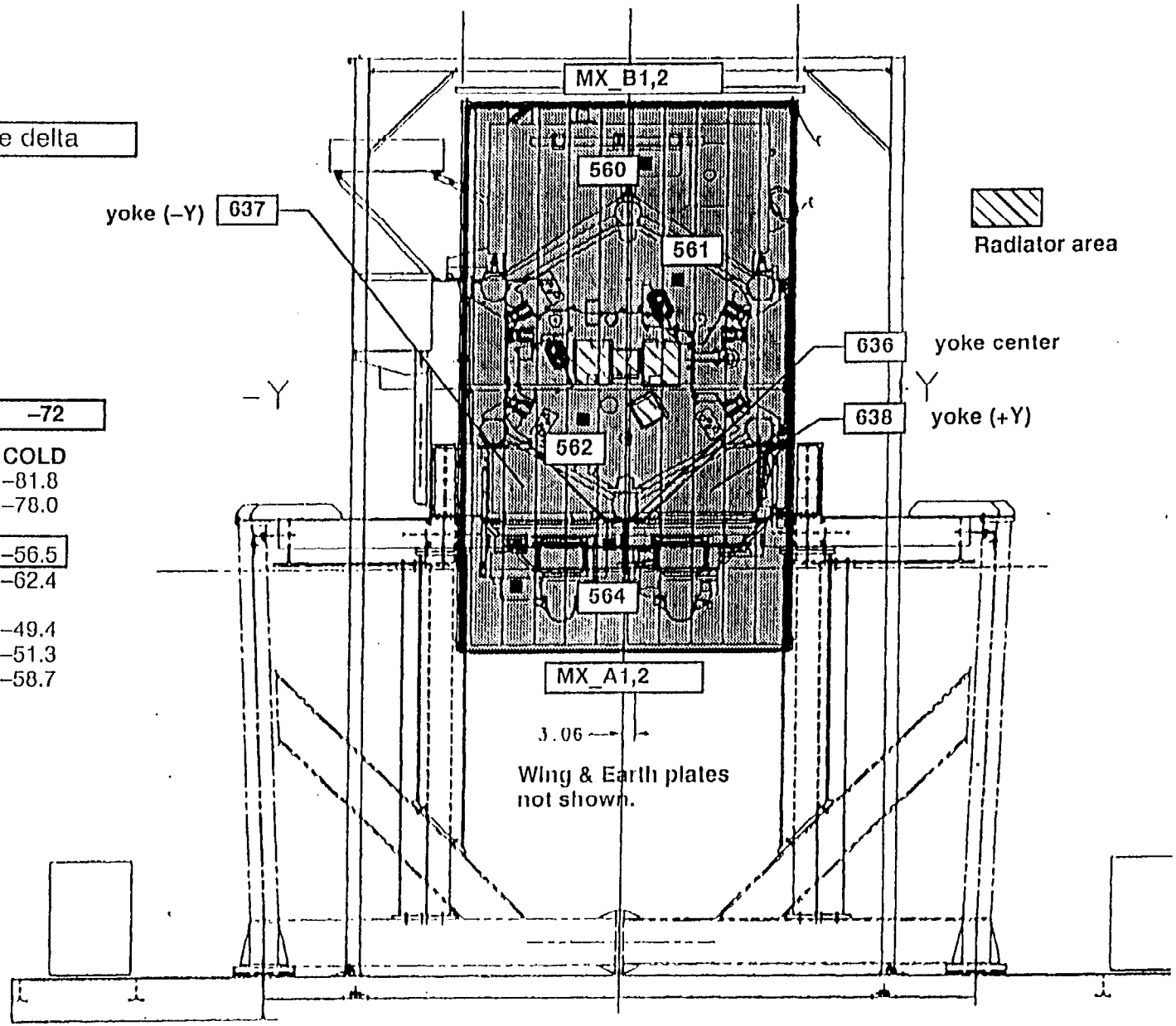


TB Test Overview
–X Thermal Control Zone

LOCKHEED MARTIN

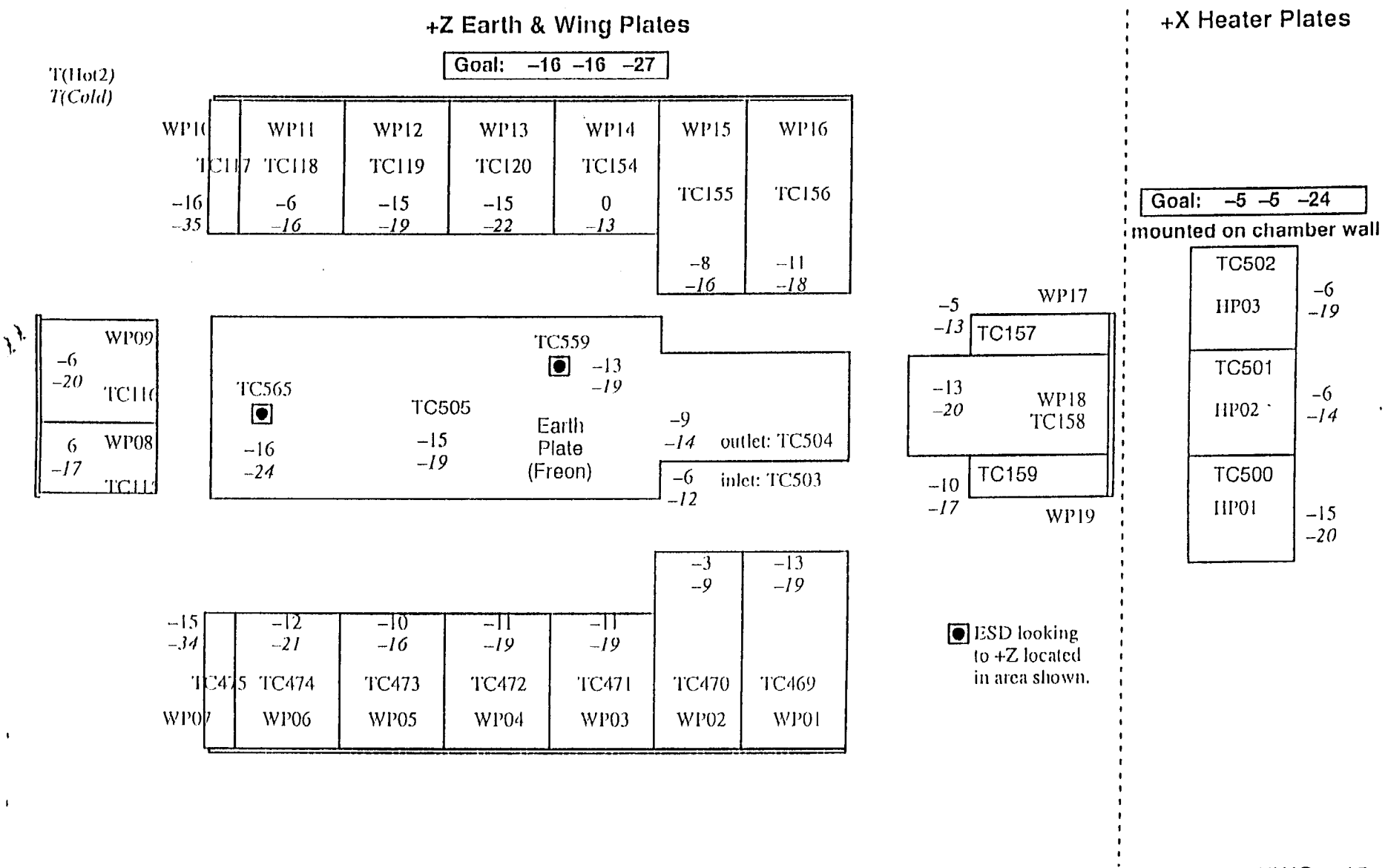
TC not used due to large delta

Goal:	–43	–43	–72
TC #	HOT1	HOT2	COLD
560	–44.5	–44.5	–81.8
561	–57.5	–57.6	–78.0
562	–9.8	–9.8	–56.5
564	–47.7	–48.0	–62.4
636	–40.0	–40.1	–49.4
637	–44.2	–44.3	–51.3
638	–48.1	–48.3	–58.7



TB Test Overview
+Z , +X Thermal Control Zone

LOCKHEED MARTIN

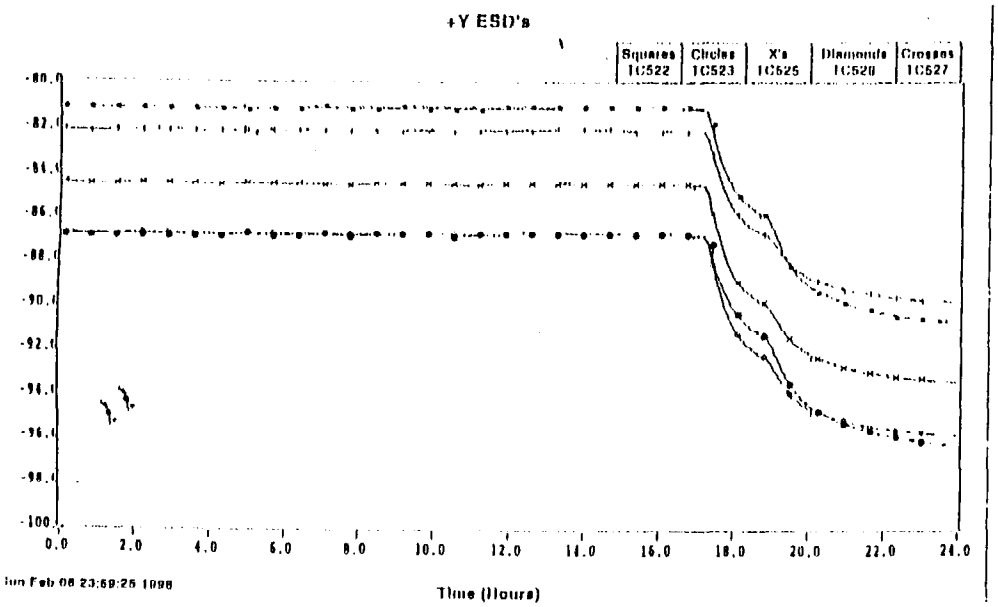


TB Test Overview

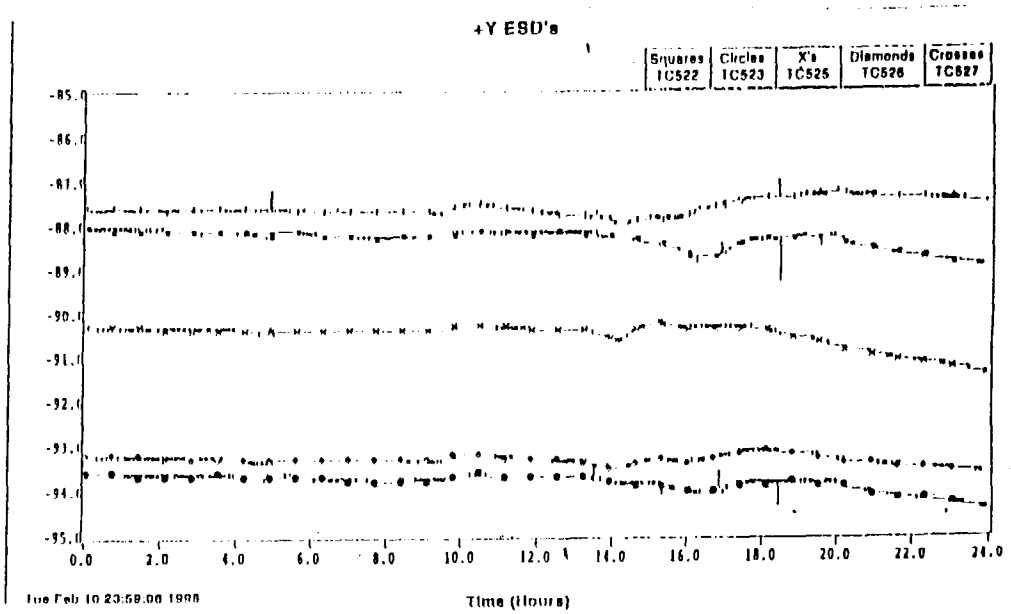
Sample +Y Thermal Control Zone Temperatures

LOCKHEED MARTIN

Hot TB



Cold TB



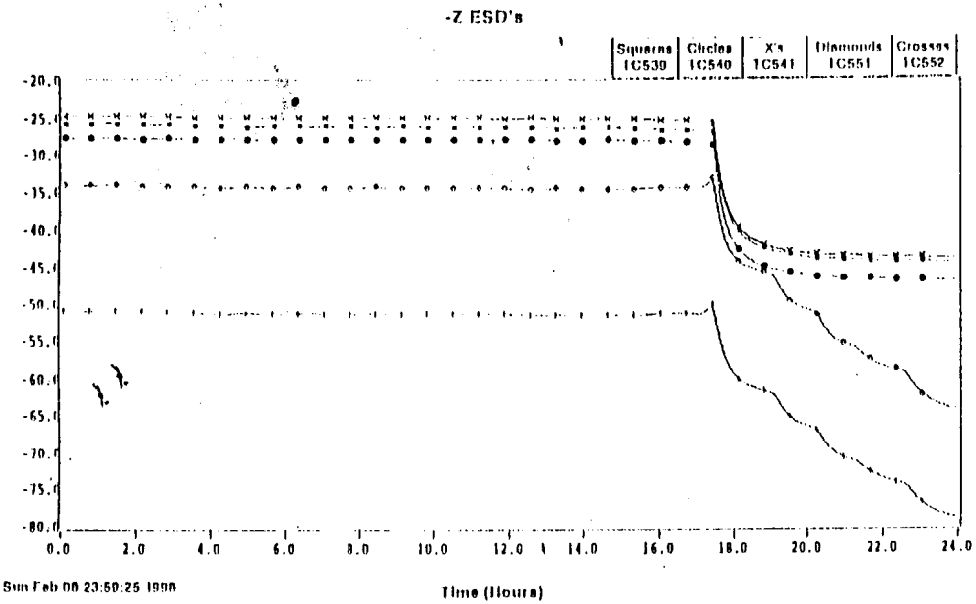
Environments very stable at Thermal Balance periods

TB Test Overview

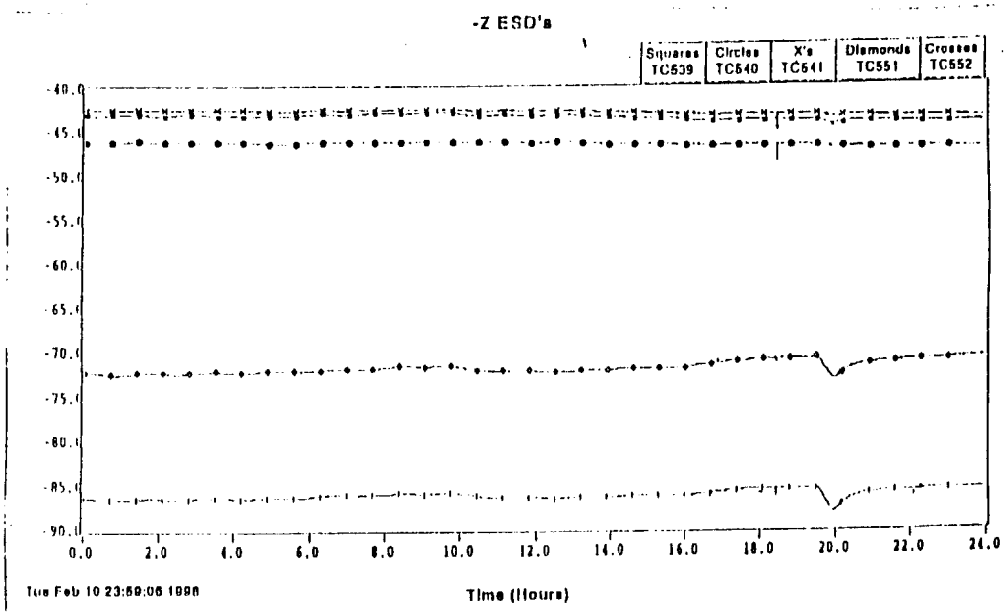
Sample –Z Thermal Control Zone Temperatures

LOCKHEED MARTIN

Hot TB



Cold TB



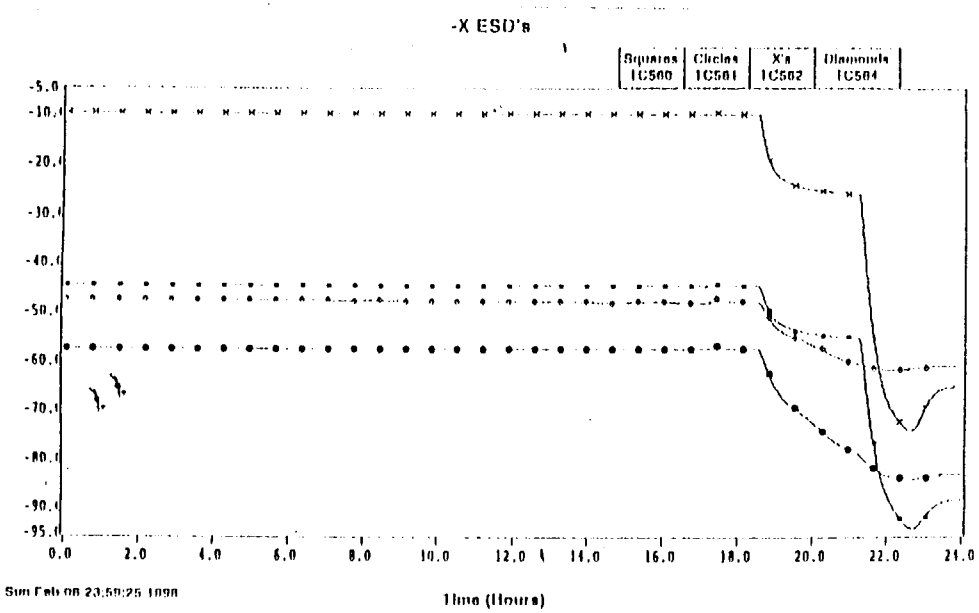
Environments very stable at Thermal Balance periods

TB Test Overview

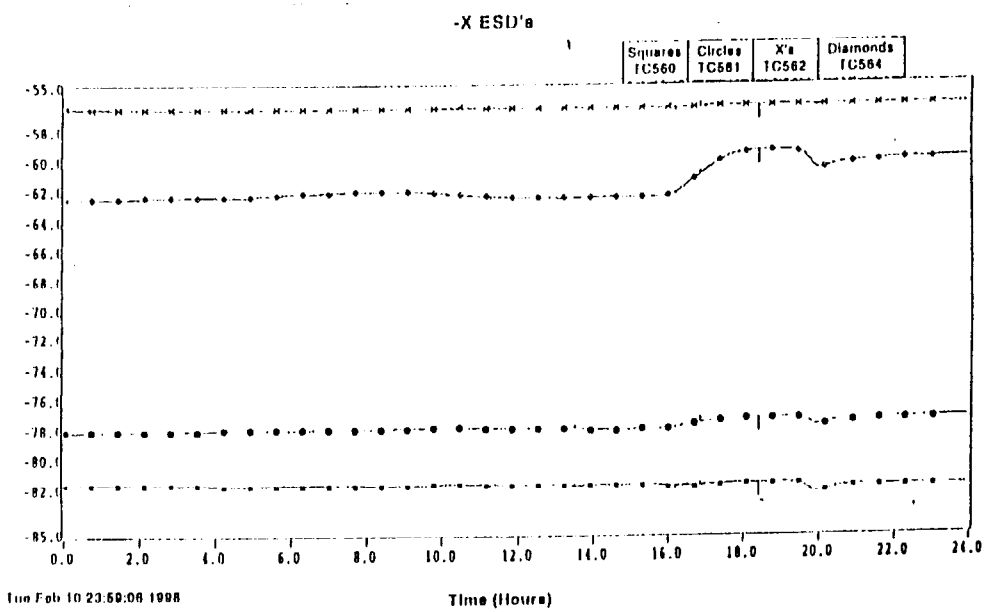
Sample –X Thermal Control Zone Temperatures

LOCKHEED MARTIN

Hot TB



Cold TB



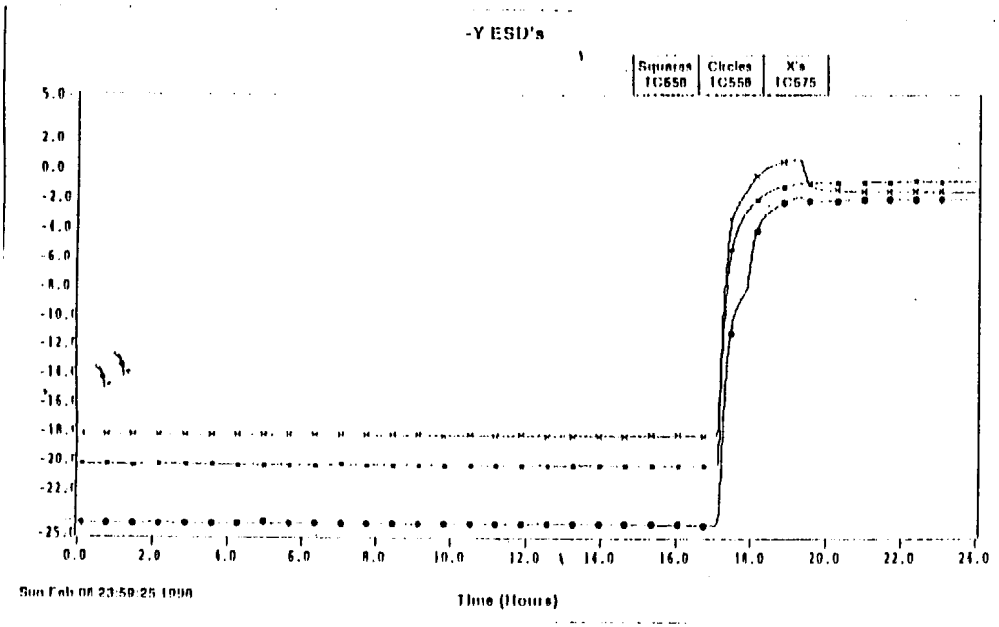
Environments very stable at Thermal Balance periods

TB Test Overview

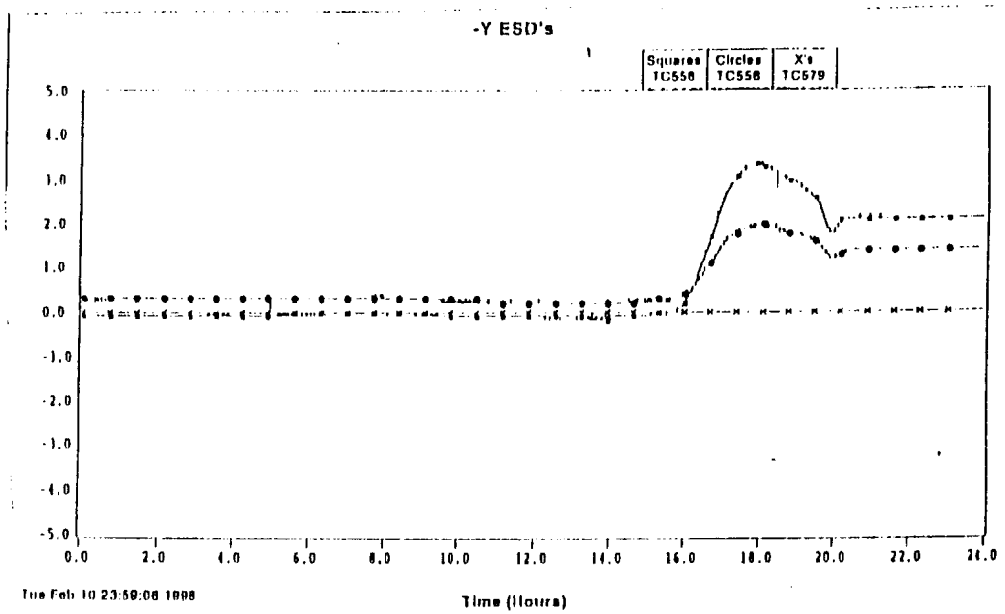
Sample –Y Thermal Control Zone Temperatures

LOCKHEED MARTIN

Hot TB



Cold TB



Environments very stable at Thermal Balance periods

Introduction

TV/TB Test Description/Goals

TB Test Overview

Post–Test Activities

Thermal Model Correlation Results

TCS Hardware Performance Review

Conclusions/Recommendations

Post–Test Activities
Radiator Areas

LOCKHEED MARTIN

- Measured all EM radiator areas in high bay after thermal vacuum testing and compared to thermal installation drawing requirements.
- Radiator areas were installed within 5% of drawing areas except for Sensor EM +Y (+11%) and –Z (+20%) radiators (drawing did NOT include changes made at Sensor TVAC, but hardware was correct).
- Radiator areas were modelled pre–test within 3% of measurements, except for Sensor EM (above), Comm EM (SCC1 only), and PBAT.

All radiator areas have been updated to measured dimensions.

Post–Test Activities
Thermo–Optical Properties

LOCKHEED MARTIN

- Silver Teflon (AgTef) radiator material and MLI outer layer (Alum Kapton) material normal emittance were measured post–TV by the Swales Aerospace Thermal Coatings Group.
  - Using above measurements, normal emittance was found to be slightly less than pre–test values:

Material	Pre–Test Value	Measured Value
AgTef	0.80	0.76
MLI (AlKap)	0.75	0.72

- Documented via Swales memo 2103–009/WCP–001, 04/27/98 (see attachment # 1)
- Properties have been updated in TRASYS.

These new values will be used for on–orbit analysis.

Post–Test Activities
Component Dissipations

LOCKHEED MARTIN

- Key to the correlation effort was the ability to accurately determine individual component (including Instruments) dissipations.
- The dissipation for most of the significantly dissipating S/C components was able to be determined from S/C telemetry
- Current telemetry data used where available to determine input power to boxes. For the most part this data was relatively simple to retrieve. S/C bus voltage was assumed to be 120V (actual voltage varied depending on orbit condition)
- Losses in boxes that feed others determined using box test data, e.g.:
  - BPC dissipations based on bus (or battery discharge) loads and 93% efficiency.
  - PSU and IRU similar, as are all EPCs.
  - Battery cell dissipations based on P, V, and I telemetry similar to W/H BBAT TB Test correlation.
  - SSU dissipations based on EPC input and total SA load telemetry.
- If current telemetry not available, dissipations based on box test data.
- "Orbit Average" determined using Lotus spreadsheet for boxes with duty cycle.

Values to use for mission predicts will be update based on values measured during test

Correlation Results:

INSTRUMENTS

CERES Correlation Results

LOCKHEED MARTIN

- Model Configuration
  - CERES AFT & FORE models: Version 6 Hot Case.
  - Selected Crosstrack mode for CERES FORE
  - Selected Safe mode for CERES AFT
- Model Changes
  - Implemented closed covers on Sensor Head
  - Distributed Space couplings among thermal vacuum sinks
  - Activated Model Heaters
  - Eliminated impressed Solar flux on sensor head nodes (beneath closed covers)
  - Corrected sink couplings to node 41006 (CERES AFT)
  - To compensate for coarse model granularity in the reduced thermal model, ΔTs (LaRC supplied) were added to model–produced temperatures for specific temperature telemetry points as shown:
    - – TT005/TT035 CE#_TR_TTSEA add 12 ^{0}C to predict
    - – TT014/TT044 CE#_TR_TDADC add 21 ^{0}C to predict
    - – TT020/TT050 CE#_TR_TIPRO add 7 ^{0}C to predict
    - – TT021/TT051 CE#_TR_TIADC add 18 ^{0}C to predict

    where # = F for FORE or A for Aft

CERES Correlation Results

LOCKHEED MARTIN

– Reduced power dissipations by 2.0W (Applied factors of 0.9622(F) & 0.9602(A))

CERES FORE (CROSSTRACK MODE)			CERES AFT (SAFE MODE)		
NODE	Q old (W)	Q correl (W)	NODE	Q old (W)	Q correl (W)
40001	17.25	16.60	40001	16.14	15.50
40011	0.62	0.60	40011	0.62	0.60
40013	2.00	1.92	40013	1.40	1.34
40018	5.30	5.10	40018	5.30	5.09
40012	2.17	2.09	40012	2.17	2.08
40014	2.40	2.31	40014	1.40	1.34
40015	11.00	10.58	40015	11.00	10.56
40016	0.20	0.19	40016	0.20	0.19
40017	5.70	5.48	40017	5.70	5.47
40019	0.10	0.096	40019	0.10	0.096
40024	6.22	5.98	40024	6.22	5.97
Total	52.96	50.96	Total	50.25	48.25

CERES AFT Correlation Results

LOCKHEED MARTIN

CORRELATION RESULTS FROM
CASE 1 HOT2 BALANCE PLATEAU

GROUP # 13 13 CERES-A TLM

SENSOR DESCRIPTION	TEST	PREDICT	DELT P-T	FLAG
TT031 CEA_TR_TSTOT	37.3	37.9	0.6	
TT032 CEA_TR_TSSW	38.0	37.9	-0.1	
TT033 CEA_TR_TSLW	37.6	37.9	0.3	
TT034 CEA_TR_TSMOD	19.8	20.0	0.2	
TT035 CEA_TR_TSEA	31.4	28.2	-3.2	
TT036 CEA_TR_TESPC	16.4	15.9	-0.5	
TT037 CEA_TR_TELBC	10.7	9.3	-1.4	
TT038 CEA_TR_TESPM	17.3	15.9	-1.4	
TT039 CEA_TR_TELBM	10.4	11.2	0.8	
TT040 CEA_TR_TERAD	7.0	5.3	-1.7	
TT041 CEA_TR_TECA	9.9	8.5	-1.4	
TT042 CEA_TR_TDRAD	10.8	9.3	-1.5	
TT043 CEA_TR_TDPRO	12.9	10.3	-2.6	
TT044 CEA_TR_TDADC	30.0	31.3	1.3	
TT045 CEA_TR_TAZBU	9.6	7.7	-1.9	
TT049 CEA_TR_TIRAD	4.0	5.0	1.0	
TT050 CEA_TR_TIPRO	13.2	12.0	-1.2	
TT051 CEA_TR_TIADC	24.6	23.0	-1.6	
TT052 CEA_TR_TPED2	5.4	8.5	3.1	
TT053 CEA_TR_TPCA	9.9	10.5	0.6	

NUMBER OF VIOLATIONS = 4

STATISTICAL ANALYSIS

GROUP = ALL
AV DELTA = -0.5 STANDARD DEVIATION = 1.5

GROUP # 13 13 CERES-A TLM

SENSOR DESCRIPTION	TEST	PREDICT	DELT P-T	FLAG
TT031 CEA_TR_TSTOT	37.8	37.9	0.1	
TT032 CEA_TR_TSSW	37.8	37.9	0.1	
TT033 CEA_TR_TSLW	37.9	37.9	0.0	
TT034 CEA_TR_TSMOD	15.1	16.6	1.5	
TT035 CEA_TR_TSEA	24.5	24.0	-0.5	
TT036 CEA_TR_TESPC	10.5	11.8	1.3	
TT037 CEA_TR_TELBC	4.8	5.2	0.4	
TT038 CEA_TR_TESPM	11.9	11.8	-0.1	
TT039 CEA_TR_TELBM	4.3	7.2	2.9	
TT040 CEA_TR_TERAD	1.1	1.0	-0.1	
TT041 CEA_TR_TECA	4.8	4.4	-0.4	
TT042 CEA_TR_TDRAD	6.0	5.2	-0.8	
TT043 CEA_TR_TDPRO	8.3	6.2	-2.1	
TT044 CEA_TR_TDADC	25.1	27.2	2.1	
TT045 CEA_TR_TAZBU	4.0	3.8	-0.2	
TT049 CEA_TR_TIRAD	-3.4	1.1	4.5	
TT050 CEA_TR_TIPRO	7.2	8.1	0.9	
TT051 CEA_TR_TIADC	18.9	19.1	0.2	
TT052 CEA_TR_TPED2	3.2	4.7	1.5	
TT053 CEA_TR_TPCA	3.2	6.7	3.5	

NUMBER OF VIOLATIONS = 4

STATISTICAL ANALYSIS

GROUP = ALL
AV DELTA = 0.7 STANDARD DEVIATION = 1.6

CERES FORE Correlation Results

LOCKHEED MARTIN

- Temperature Comparison Test/Predicts

CORRELATION RESULTS FROM
CASE 1 HOT2 BALANCE PLATEAU

GROUP # 12 12 CERES-F TLM

SENSOR DESCRIPTION	TEST	PREDICT	DELT P-T	FLAG
TT001 CEF_TR_TSTOT	37.9	38.0	0.1	
TT002 CEF_TR_TSSW	37.9	38.0	0.1	
TT003 CEF_TR_TSLW	37.9	38.0	0.1	
TT004 CEF_TR_TSMOD	23.7	26.5	2.8	
TT005 CEF_TR_TTSEA	33.8	36.3	2.5	
TT006 CEF_TR_TESPC	20.5	24.1	3.6	
TT007 CEF_TR_TELBC	15.5	18.2	2.7	
TT008 CEF_TR_TESPM	21.3	24.1	2.8	
TT009 CEF_TR_TELBM	15.5	20.5	5.0	*
TT010 CEF_TR_TERAD	12.4	15.0	2.6	
TT011 CEF_TR_TECA	17.0	18.1	1.1	
TT012 CEF_TR_TDRAD	15.4	18.2	2.8	
TT013 CEF_TR_TDPRO	17.0	19.4	2.4	
TT014 CEF_TR_TDADC	35.5	40.4	4.9	
TT015 CEF_TR_TAZBU	14.9	15.9	1.0	
TT016 CEF_TR_TAZBL	14.6	15.9	1.3	
TT019 CEF_TR_TIRAD	11.3	13.5	2.2	
TT020 CEF_TR_TIPRO	19.3	20.5	1.2	
TT021 CEF_TR_TIADC	31.1	31.5	0.4	
TT022 CEF_TR_TPED2	12.1	16.3	4.2	
TT023 CEF_TR_TPCA	16.4	18.0	1.6	
TT024 CEF_TR_TPCARD	17.0	18.0	1.0	

NUMBER OF VIOLATIONS = 5

STATISTICAL ANALYSIS

GROUP = ALL
AV DELTA = 2.1 STANDARD DEVIATION = 1.5

CORRELATION RESULTS FROM
CASE 2 COLD BALANCE PLATEAU

GROUP # 12 12 CERES-F TLM

SENSOR DESCRIPTION	TEST	PREDICT	DELT P-T	FLAG
TT001 CEF_TR_TSTOT	37.9	38.0	0.1	
TT002 CEF_TR_TSSW	37.9	38.0	0.1	
TT003 CEF_TR_TSLW	37.9	38.0	0.1	
TT004 CEF_TR_TSMOD	22.0	24.7	2.7	
TT005 CEF_TR_TTSEA	32.0	34.1	2.1	
TT006 CEF_TR_TESPC	18.4	21.8	3.4	
TT007 CEF_TR_TELBC	13.2	16.2	3.0	
TT008 CEF_TR_TESPM	19.4	21.8	2.4	
TT009 CEF_TR_TELBM	12.9	18.4	5.5	*
TT010 CEF_TR_TERAD	9.6	12.6	3.0	
TT011 CEF_TR_TECA	14.6	15.8	1.2	
TT012 CEF_TR_TDRAD	13.0	16.2	3.2	
TT013 CEF_TR_TDPRO	14.9	17.3	2.4	
TT014 CEF_TR_TDADC	33.5	38.3	4.8	
TT015 CEF_TR_TAZBU	12.4	13.9	1.5	
TT016 CEF_TR_TAZBL	12.1	13.9	1.8	
TT019 CEF_TR_TIRAD	8.3	11.4	3.1	
TT020 CEF_TR_TIPRO	16.7	18.4	1.7	
TT021 CEF_TR_TIADC	27.9	29.4	1.5	
TT022 CEF_TR_TPED2	9.4	14.4	5.0	*
TT023 CEF_TR_TPCA	14.0	16.3	2.3	
TT024 CEF_TR_TPCARD	14.6	16.3	1.7	

NUMBER OF VIOLATIONS = 6

STATISTICAL ANALYSIS

GROUP = ALL
AV DELTA = 2.4 STANDARD DEVIATION = 1.5

CERES Correlation Results

LOCKHEED MARTIN

- Power Balance (W)

	Measured Orbit Average [1]		Model	Pre-Test Model		Post Test Model Component Dissipation [2]		Post Test Model Heater Estimate	
Instrument	Hot TB	Cold TB	Jun-96	TB.hot	TB.cold	TB.hot	TB.cold	TB.hot [3]	TB.cold [3]
AFT	49.8	47.9		53.0	53.0	48.3	48.3	2.8(2.7)	3.4(3.6)
FORE	52.6	51.1		53.0	53.0	51.0	51.0	1.6(1.8)	1.9(2.2)
Total	102.4	99.0	96.0	106.0	106.0	99.3	99.3	4.4(4.5)	5.3(5.8)

Note 1 See data at end of Instrument correlation section
Note 2 Does not contain heater power estimate, i.e., to calculate total power in model, add the corresponding "Dissipation" and "Heater Estimate" columns.
Note 3 Measured values from test telemetry in parentheses

- **Discussion of Results CERES AFT**
  - **With the addition of the ΔTs, excellent agreement between model and test has been achieved:**
    - – Hot TB : Mean ΔT = –0.5 ^{0}C, standard deviation < 2 ^{0}C, and with all individual ΔTs < 3 ^{0}C
    - – Cold TB: Mean ΔT = –0.7 ^{0}C, standard deviation < 2 ^{0}C, and with all individual ΔTs < 4.5 ^{0}C
  - **The impressed dissipation alongwith predicted heater power exceeds the measured power by 1.3W in Hot TB and 3.8W in the Cold TB. It is believed that further "tweaking" of the model internal dissipation would reduce these ΔQs to within the uncertainty range of the measured values.**
- Discussion of Results CERES FORE
  - **With the addition of the ΔTs, good agreement between model and test has been achieved:**
    - – Hot TB : Mean ΔT = +2.1 ^{0}C, standard deviation < 2 ^{0}C, and with all individual ΔTs < 5.5 ^{0}C
    - – Cold TB: Mean ΔT = +2.4 ^{0}C, standard deviation < 2 ^{0}C, and with all individual ΔTs < 5 ^{0}C
  - **The impressed dissipation alongwith predicted heater power exceeds the measured power by 1.8W in the Cold TB, and is identical in the Hot TB case. These are within an acceptable ranges.**

Both CERES AFT & FORE RTMs verified

MISR Correlation Results

LOCKHEED MARTIN

- Model Configuration
  - MISR model: Version 7 Hot Case.
  - Operational (Science) mode selected
- Model Changes
  - Distributed Space couplings among thermal vacuum sinks
  - Converted variable sun/eclipse dissipations to orbit average values (no changes to delivered dissipation values)
  - Activated Model Heaters
    - 21.3W Hot case heater power
    - 28.0W Cold case heater power
- Telemetry Changes
  - Eliminated telemetry points with erroneous calibration curves:
    - TT069 MIS_TP_OBMY
    - TT070 MIS_TP_OBPY

MISR Correlation Results

LOCKHEED MARTIN

- Temperature Comparison Test/Predicts

CORRELATION RESULTS FROM
CASE 1 HOT2 BALANCE PLATEAU

GROUP # 14 14 MISR TLM

SENSOR DESCRIPTION	TEST	PREDICT	DELT P-T	FLAG
TT061 MIS_TR_SYSPSA	15.6	16.1	0.5	
TT062 MIS_TR_SYSPSB	7.2	8.1	0.9	
TT063 MIS_TP_ELRADPX	-5.6	4.1	9.7	*
TT064 MIS_TR_ELRADMX	9.0	7.5	-1.5	
TT065 MIS_TPTECRADMX	-8.2	-1.3	6.9	*
TT066 MIS_TRTECRADPX	-1.8	1.4	3.2	
TT067 MIS_TR_MTRCOV	-0.5	-10.8	-10.3	*
TT071 MIS_TR_OBCONTR	5.0	7.3	2.3	
TT074 MIS_TR_OB	4.7	7.3	2.6	

NUMBER OF VIOLATIONS = 3

STATISTICAL ANALYSIS

GROUP = ALL
AV DELTA = 1.6 STANDARD DEVIATION = 5.6

CORRELATION RESULTS FROM
CASE 2 COLD BALANCE PLATEAU

GROUP # 14 14 MISR TLM

SENSOR DESCRIPTION	TEST	PREDICT	DELT P-T	FLAG
TT061 MIS_TR_SYSPSA	12.8	12.4	-0.4	
TT062 MIS_TR_SYSPSB	3.6	4.4	0.8	
TT063 MIS_TP_ELRADPX	-9.8	0.1	9.9	*
TT064 MIS_TR_ELRADMX	6.8	3.8	-3.0	
TT065 MIS_TPTECRADMX	-3.5	-4.7	-1.2	
TT066 MIS_TRTECRADPX	-9.8	-1.7	8.1	*
TT067 MIS_TR_MTRCOV	0.8	-8.0	-8.8	*
TT071 MIS_TR_OBCONTR	4.9	4.7	-0.2	
TT074 MIS_TR_OB	4.4	4.7	0.3	

NUMBER OF VIOLATIONS = 3

STATISTICAL ANALYSIS

GROUP = ALL
AV DELTA = 0.6 STANDARD DEVIATION = 5.6

MISR Correlation Results

LOCKHEED MARTIN

- Power Balance (W)

	Measured Orbit Average [1]		Model	Pre-Test Model		Post Test Model Component Dissipation [2]		Post Test Model Heater Estimate	
Instrument	Hot TB	Cold TB	Jun-96	TB.hot	TB.cold	TB.hot	TB.cold	TB.hot	TB.cold
MISR	74.8	80.1	77.9	55.4	55.4	55.4	55.4	22.3	25.1

Note 1 See data at end of Instrument correlation section
Note 2 Does not contain heater power estimate, i.e., to calculate total power in model, add the corresponding "Dissipation" and "Heater Estimate" columns.

- Discussion of Results
  - Good agreement between model and test has been achieved:
    - - Hot TB : Mean $\Delta T = +1.6\ ^0C$, standard deviation $< 6\ ^0C$
    - - Cold TB: Mean $\Delta T = +0.6\ ^0C$, standard deviation $< 6\ ^0C$
  - Mean deviation values indicate that a good thermal balance has been achieved (for the points selected). The slightly high standard deviation refects the impact of steady-state modelling (orbit average) of a transiently operating Instrument, as well as the influence of three specific points TT063, TT067 and TT070 which exhibit ΔTs in excess of 5 ^{0}C. These points are located on radiators and a cover.
  - The impressed dissipation alongwith predicted heater power exceeds the measured power by 2.9W in Hot TB and 0.4W in the Cold TB. These values are acceptable, based on the accuracy of the heater power predictions, measured/averaged telemetry values and the orbit average variations.

MISR RTM verified

MODIS Correlation Results

LOCKHEED MARTIN

- Model Configuration
  - MODIS model: Version 6 Hot Case.
  - Selected Operational (Science) mode
- Model Changes
  - Activated Model Heaters
  - Distributed Space couplings among thermal vacuum sinks
  - Changed node # 43049, Space View Port, from a boundary to an arithmetic node per previous S/C model practice.

MODIS Correlation Results

LOCKHEED MARTIN

- Temperature Comparison Test/Predicts

CORRELATION RESULTS FROM
CASE 1 HOT2 BALANCE PLATEAU

GROUP # 17 17 MODIS TLM

SENSOR DESCRIPTION	TEST	PREDICT	DELT P-T	FLAG
TT101 MF_CALBKHD_SR	-9.0	-7.1	1.9	
TT102 MF_CVR_OP_SR	-9.0	-8.0	1.0	
TT103 MF_TOP_BY_KM1	-7.0	-6.8	0.2	
TT104 MF_TOP_BY_KM2	-5.0	-6.1	-1.1	
TT105 MF_TOP_BY_KM3	-9.0	-7.1	1.9	
TT106 MF_YZ_CALBKHD	-23.0	-7.1	15.9	*
TT107 MF_Z_BKHD_BB	-18.0	-6.9	11.1	*
TT108 TE_FOLD_MIR	-11.0	-6.9	4.1	
TT109 TE_PRI_MIR	-10.0	-6.9	3.1	
TT110 TE_SEC_MIR	-11.0	-6.9	4.1	
TT111 AO_PZ_NZ_CORN	-13.0	-8.9	4.1	
TT112 AO_PZ_BY_RC	-16.0	-8.9	7.1	*
TT113 AO_VHDICH_HSG	-12.0	-8.9	3.1	
TT114 AO_SMIR_LENS	-13.5	-8.9	4.6	
TT115 AO_LWIR_LENS	-14.5	-8.9	5.6	*
TT116 AO_VIS_FPA	-12.0	-8.9	3.1	
TT117 AO_NIR_FPA	-11.0	-8.9	2.1	
TT119 ME_PSRADIATOR	1.0	-5.7	-6.7	*
TT120 PVSAM_RADIATOR	-7.0	0.9	7.9	*
TT121 PCFAM_RADIATOR	-3.0	-3.3	-0.3	
TT122 PC_CLAM_MNT	-4.0	-3.2	0.8	
TT123 ME_CHAS_TOP	-7.0	-5.7	1.3	
TT124 ME_NX_HTSINK	-9.0	-5.7	3.3	
TT126 SA_RCT1_MIR	-10.0	-4.8	5.2	*
TT127 SA_RCT2_MIR	-10.0	-4.8	5.2	*

NUMBER OF VIOLATIONS = 8

STATISTICAL ANALYSIS

GROUP = ALL
AV DELTA = 3.5 STANDARD DEVIATION = 4.2

CORRELATION RESULTS FROM
CASE 2 COLD BALANCE PLATEAU

GROUP # 17 17 MODIS TLM

SENSOR DESCRIPTION	TEST	PREDICT	DELT P-T	FLAG
TT101 MF_CALBKHD_SR	-12.0	-9.3	2.7	
TT102 MF_CVR_OP_SR	-12.0	-10.3	1.7	
TT103 MF_TOP_BY_KM1	-9.0	-8.9	0.1	
TT104 MF_TOP_BY_KM2	-7.0	-8.0	-1.0	
TT105 MF_TOP_BY_KM3	-9.0	-9.2	-0.2	
TT106 MF_YZ_CALBKHD	-28.0	-9.2	18.8	*
TT107 MF_Z_BKHD_BB	-22.0	-9.1	12.9	*
TT108 TE_FOLD_MIR	-14.0	-9.0	5.0	*
TT109 TE_PRI_MIR	-14.0	-9.0	5.0	*
TT110 TE_SEC_MIR	-15.0	-9.0	6.0	*
TT111 AO_PZ_NZ_CORN	-16.0	-10.9	5.1	*
TT112 AO_PZ_BY_RC	-16.0	-10.9	5.1	*
TT113 AO_VHDICH_HSG	-16.0	-10.9	5.1	*
TT114 AO_SMIR_LENS	-16.5	-10.9	5.6	*
TT115 AO_LWIR_LENS	-17.5	-10.9	6.6	*
TT116 AO_VIS_FPA	-15.0	-10.9	4.1	
TT117 AO_NIR_FPA	-14.0	-10.9	3.1	
TT119 ME_PSRADIATOR	1.0	-7.3	-8.3	*
TT120 PVSAM_RADIATOR	-9.0	-0.9	8.1	*
TT121 PCFAM_RADIATOR	-5.0	-5.2	-0.2	
TT122 PC_CLAM_MNT	-7.0	-5.2	1.8	
TT123 ME_CHAS_TOP	-9.0	-7.3	1.7	
TT124 ME_NX_HTSINK	-9.0	-7.3	1.7	
TT126 SA_RCT1_MIR	-13.0	-7.0	6.0	*
TT127 SA_RCT2_MIR	-13.0	-7.0	6.0	*

NUMBER OF VIOLATIONS = 14

STATISTICAL ANALYSIS

GROUP = ALL
AV DELTA = 4.1 STANDARD DEVIATION = 5.0

MODIS Correlation Results

LOCKHEED MARTIN

- Power Balance

	Measured Orbit Average [1]		Model	Pre–Test Model		Post Test Model Component Dissipation [2]		Post Test Model Heater Estimate	
Instrument	Hot TB	Cold TB	Jun–96	TB.hot	TB.cold	TB.hot	TB.cold	TB.hot	TB.cold
MODIS	166.9	171.9	125.7	134.8	134.8	134.8	134.8	0 [3]	0 [3]

Note 1 See data at end of Instrument correlation section
Note 2 Does not contain heater power estimate, i.e., to calculate total power in model, add the corresponding "Dissipation" and "Heater Estimate" columns.
Note 3 See Discussion on heater power

- Discussion of Results
  - MODIS summary results:
    - – Hot TB : Mean $\Delta T = +3.5\ ^0C$, standard deviation $< 5\ ^0C$
    - – Cold TB: Mean $\Delta T = +4.1\ ^0C$, standard deviation $< 5\ ^0C$
  - Standard deviation numbers appear to acceptable, however, mean deviations are high.
  - Measured power exceeds modelled dissipation by 32.1W and 37.1W for the Hot and Cold TB respectively. This is not the expected trend, given that the model predicted temperatures are predicting <u>higher</u> temperatures than the test.
  - The key to understanding the performance of the MODIS thermal model is the energy balance, in particular the power signatures of the 4 MODIS heater circuits.
    - – Black body heater: nominally 30W.
    - – Cold stage outgas heater: nominally 20W. According to MODIS, the power draw of this heater could be as much as 27W.
    - – Intermediate stage outgas heater: nominally 44W. Actual range 37–42W depending on power supply efficiency.
    - – Outer Stage outgas heater (nominally 60W)
  - The outer stage outgas heater was disabled during Hot and Cold TB
  - The other three were enabled with the following duty cycles:
    - – Black body heater: 20% .. Orbit average 6W (all internal)
    - – Cold stage outgas heater: 30% .. Orbit average 6W (1W internal, 5W external)
    - – Intermediate stage outgas heater: duty cycle unknown.

MODIS Correlation Results

LOCKHEED MARTIN

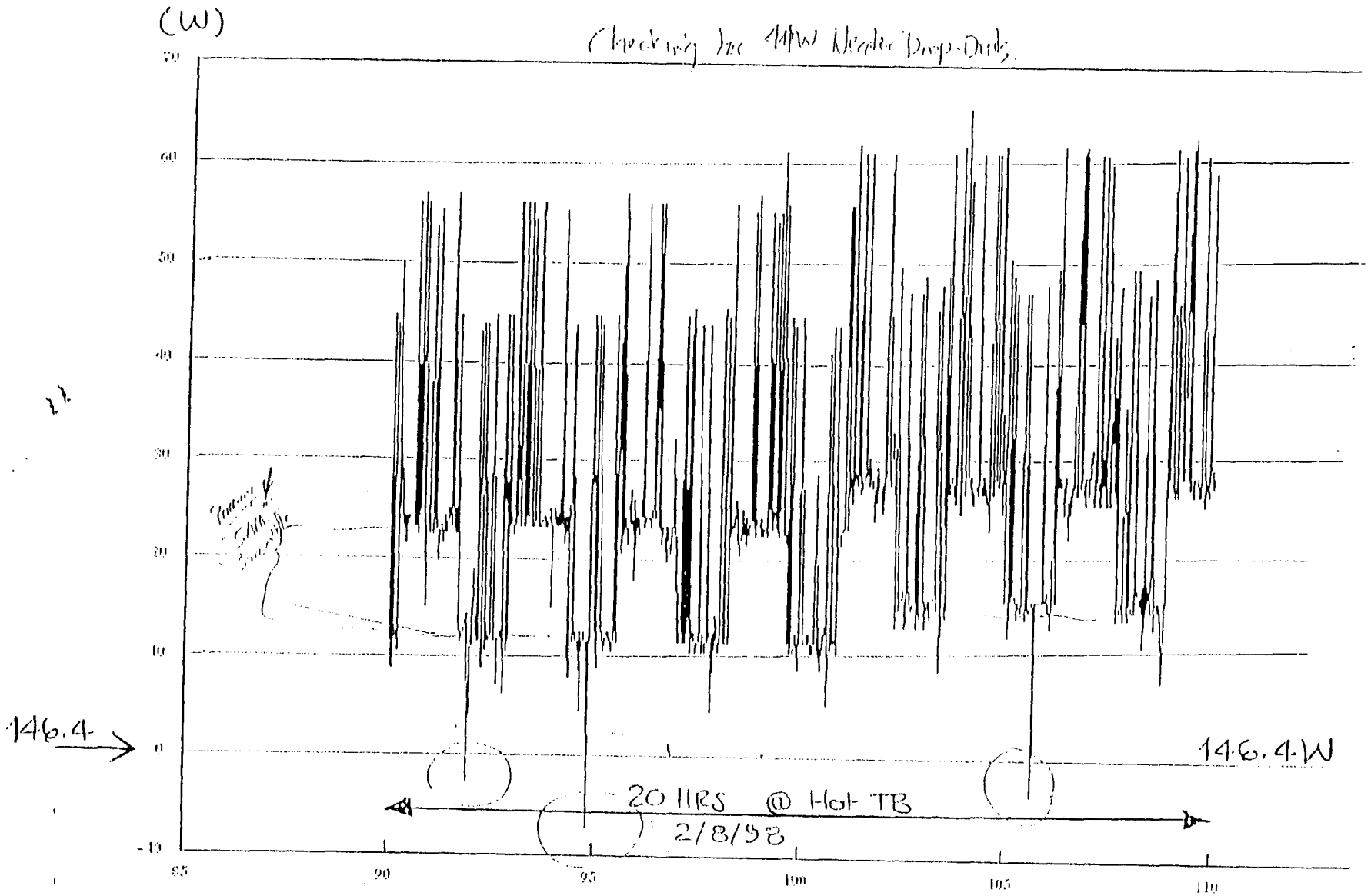
- Reviewing current telemetry (see next pages), there are a couple of fluctuations which could correspond to the intermediate stage outgas heater value (~40W). There are also some at 35W. Temperature telemetry indicates that the temperature was near to the set point of the heater (318K), and therefore it should have been on at some duty cycle. For this heater 15% of the power is internally dissipated, and 85% externally.
- Given the uncertainty of this heater, three scenarios are postulated:
  1. Heater is 100% on. Indicated power is (approx) 135+6+6+40 = 187W (20W above measured value)
  2. Heater is off. Indicated power is (approx)135+6+6 = 147W (20W below measured value).
  3. Heater is on at TBD duty cycle. Duty cycle would have to be near 50% to balance power.
- In scenario 1., the assumption that the heater is on would mean that the dissipation used by the model is too high (and should be reduced, resulting in lower predicted temperatures and thus better agreement between test and model).
- In scenario 2., the assumption that the heater is off would mean that the dissipation used by the model is too low (and should be increased, resulting in higher predicted temperatures and thus larger differences between test and model).
- In scenario 3., the assumption that the heater is at a TBD duty cycle could achieve a better power balance, however question on temperature levels still exists.
- In conclusion, it would appear that there is insufficient current/htr status telemetry to accurately validate the MODIS RTM. Further investigation by the Instrumenter and/or by using the MODIS detailed TMM may be required to fully resolve this issue.

• It is important that this model work well to assist in radiator close-out studies.

The delivered MODIS RTM appears to be predicting consistently about 4^0C higher than test

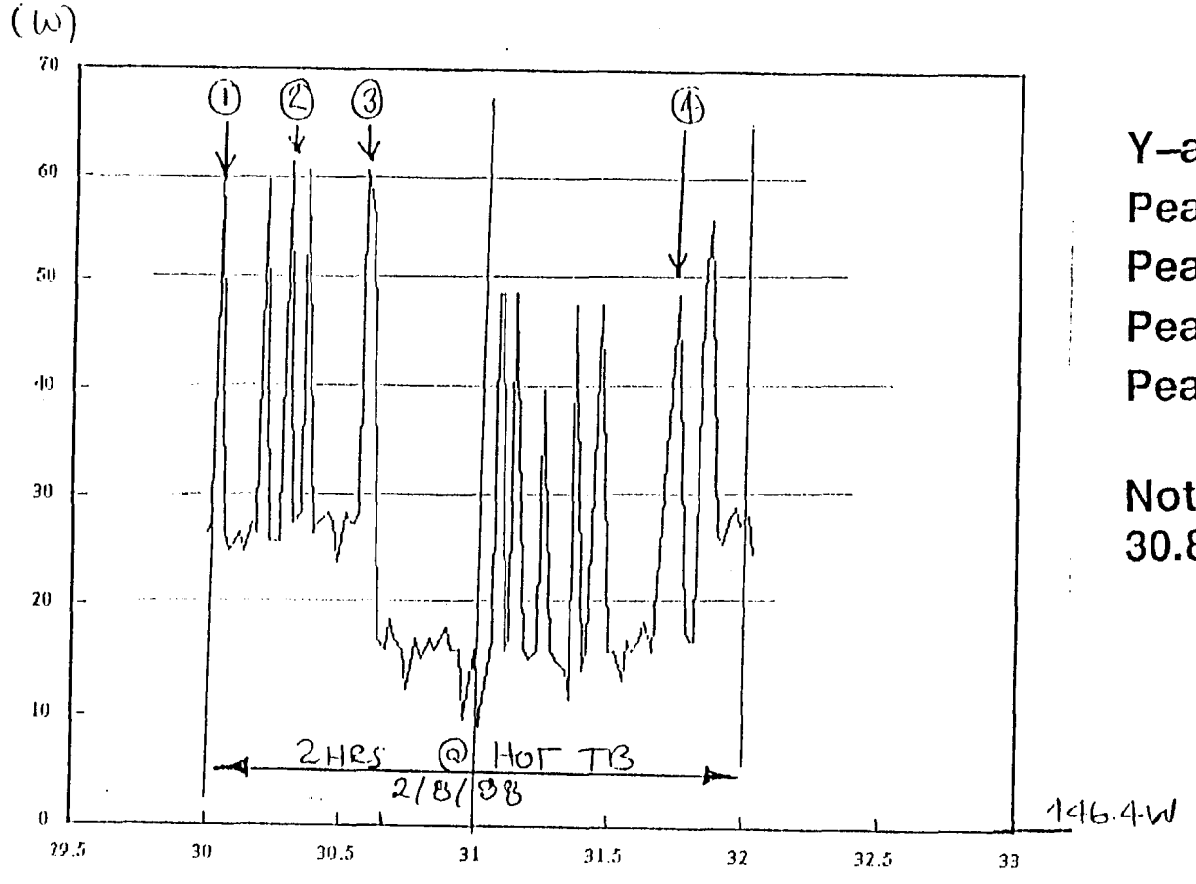
MODIS Correlation Results
Current Telemetry

LOCKHEED MARTIN



MODIS Correlation Results
Current Telemetry

LOCKHEED MARTIN



Y–axis 0=146.4W
Peak #1 =33W
Peak #2 =36W
Peak #3 =32W
Peak #4 =33W

Note approx 12W drop in level at 30.8. Increases again at 31.9

MOPITT Correlation Results

LOCKHEED MARTIN

- Model Configuration
  - MOPITT model: Version 6 Hot.
  - Operational (Science) mode selected
- Model Changes
  - Activated Model Heaters
  - Distributed Space couplings among thermal vacuum sinks
  - Increased Model power by 33.7W per MOPITT team direction. Pre–test dissipation was 270W. Initially (post–test) changed to 212.3 W as per discussion with MOPITT team.

Component	NODE	Q old (W)	Q correl (W)	Component	NODE	Q old (W)	Q correl (W)
PSM	44015	44.9	50.0	CDE	44072	27.3	33.10
Harness	44016–	1.48	nc	Scan Motors	44079–	6.0	nc
Harness	44089–	0.03	nc	Compressors	44083	36.64	59.80
Blackbodies	44057–	0	nc	Displacers	44084	1.10	nc
ICM	44065	11.0	nc	Choppers	44085–	10	nc
PLDM	44066	9.5	nc	LMCs	44108–	6	nc
SCDM	44067	7.9	nc	PMCs	44112–	6.9	nc
TCMM	44068	11.8	nc	PMC Sieve	44114	3.2	nc
PCDM	44069	1.3	nc	PDM	44123	3.5	nc
SPM1	44070	11.9	nc				
SPM2	44071	11.9	nc	Total		212.3	246.0

nc = no change

- Telemetry Changes
  - Added 8 telemetry points to the correlation: TT300–305, TT308/309 (see comparison table)

MOPITT Correlation Results

LOCKHEED MARTIN

- Temperature Comparison Test/Predicts

CORRELATION RESULTS FROM
CASE 1 HOT2 BALANCE PLATEAU

GROUP # 15 15 MOPITT TLM

SENSOR DESCRIPTION	TEST	PREDICT	DELT P-T	FLAG
TT081 MOP_TDBDUBPMAX	19.6	18.7	-0.9	
TT082 MOP_TDBDUBPMIN	21.1	18.5	-2.6	
TT083 MOP_TDBDU_PSMA	2.3	9.7	7.4	*
TT084 MOP_TDBDU_PSMB	6.7	9.7	3.0	
TT085 MOP_TD_BPLT_1	16.5	18.0	1.5	
TT086 MOP_TD_BPLT_2	19.4	19.1	-0.3	
TT087 MOP_TD_BPLT_3	19.0	18.1	-0.9	
TT088 MOP_TD_PSM	2.5	9.7	7.2	*
TT300 _SCAN2_MTR	23.0	23.7	0.7	
TT301 _SCAN3_MTR	23.6	23.7	0.1	
TT302 _SPACE_BAFFLE	10.6	11.7	1.1	
TT303 _SPACE_MOTOR	11.5	11.5	0.0	
TT304 _EARTH_BAFFLE	10.7	10.6	-0.1	
TT305 _EARTH_MOTOR	8.5	9.4	0.9	
TT308 _CHOP2_MTR	23.2	20.8	-2.4	
TT309 _CHOP3_MTR	23.7	22.4	-1.3	

NUMBER OF VIOLATIONS = 2

STATISTICAL ANALYSIS

GROUP = ALL
AV DELTA = 0.8 STANDARD DEVIATION = 2.9

CORRELATION RESULTS FROM
CASE 2 COLD BALANCE PLATEAU

GROUP # 15 15 MOPITT TLM

SENSOR DESCRIPTION	TEST	PREDICT	DELT P-T	FLAG
TT081 MOP_TDBDUBPMAX	18.9	18.7	-0.2	
TT082 MOP_TDBDUBPMIN	21.1	18.5	-2.6	
TT083 MOP_TDBDU_PSMA	0.6	7.9	7.3	*
TT084 MOP_TDBDU_PSMB	5.2	7.9	2.7	
TT085 MOP_TD_BPLT_1	15.8	18.0	2.2	
TT086 MOP_TD_BPLT_2	19.2	19.0	-0.2	
TT087 MOP_TD_BPLT_3	19.0	18.1	-0.9	
TT088 MOP_TD_PSM	0.9	7.9	7.0	*
TT300 _SCAN2_MTR	21.8	23.7	1.9	
TT301 _SCAN3_MTR	22.3	23.7	1.4	
TT302 _SPACE_BAFFLE	9.5	11.6	2.1	
TT303 _SPACE_MOTOR	10.5	11.5	1.0	
TT304 _EARTH_BAFFLE	9.0	10.5	1.5	
TT305 _EARTH_MOTOR	6.8	9.1	2.3	
TT308 _CHOP2_MTR	22.6	20.8	-1.8	
TT309 _CHOP3_MTR	22.8	22.3	-0.5	

NUMBER OF VIOLATIONS = 2

STATISTICAL ANALYSIS

GROUP = ALL
AV DELTA = 1.4 STANDARD DEVIATION = 2.7

MOPITT Correlation Results

LOCKHEED MARTIN

- Power Balance (W)

	Measured Orbit Average [1]		Model	Pre–Test Model		Post Test Model Component Dissipation [2]		Post Test Model Heater Estimate	
Instrument	Hot TB	Cold TB	Jun–96	TB.hot	TB.cold	TB.hot	TB.cold	TB.hot	TB.cold
MOPITT	228.4	227.2	275.0	270.0	270.0	246.0	246.0	0	0

Note 1 See data at end of Instrument correlation section
Note 2 Does not contain heater power estimate, i.e., to calculate total power in model, add the corresponding "Dissipation" and "Heater Estimate" columns.

- Discussion of Results
  - Overall, good agreement between model and test has been achieved:
    - – Hot TB : Mean $\Delta T = +0.8\ ^0C$, standard deviation $< 3\ ^0C$
    - – Cold TB: Mean $\Delta T = +1.4\ ^0C$, standard deviation $< 3\ ^0C$
  - The impressed dissipation exceeds the measured power by 17.6W in Hot TB and 18.8W in the Cold TB.
  - General temperature level predicted by the model is high; probably resulting from the higher than measured dissipation. Specifically, the PSM temperatures (TT083 & TT088) are over–predicted by 7 ^0C in both Hot and Cold TB, indicating either nodal/telem position issues and/or too high model dissipations. This should be evaluated further by the MOPITT team.

Overall good agreement between model & test. Need to resolve PSM modelling/dissipation issue.

ASTER Correlation Results

LOCKHEED MARTIN

- Telemetry Changes
  - Added telemetry points to the correlation (see comparison table)
- Model Configuration
  - ASTER model versions:
    - – SWIR version 7 Hot Case
    - – TIR version 6 Hot Case
    - – VNIR version 5.2 Hot Case
    - – MPS version 7 Hot Case
    - – CSP version 6 Hot Case
  - Hot TB: 2–orbit observation mode
  - Cold TB: Standby mode
- Model Changes
  - Activated Model Heaters
  - Distributed Space couplings among thermal vacuum sinks
  - Determined MPS & CSP dissipation via current telemetry
  - MPS A–side enabled, B–side disabled, and derived dissipation from current telemetry & power consumption curves
  - CSP, VNIR, SWIR, MPS, cold case dissipations revised to remove 16 min "observation" dissipations.
  - TIR hot case revised to include 16 min observation
  - Heater powers imposed as constant Q for TIR Nodes 45551 & 45561 (4W and 1W respectively, for both TB.hot and TB.cold)

ASTER Correlation Results

LOCKHEED MARTIN

		TB.hot (2–orbit Observation)		TB.cold (Standby)	
Component	NODE	Q old (W)	Q correl (W)	Q old (W)	Q correl (W)
CSP	45720	16.2	15.6	16.2	13.6
	45731	8.4	8.1	8.4	7.1
	45732	0	nc	0	nc
MPS B	45600	27.6	0	27.6	0
	45605	3.4	0	3.4	0
MPS A/B	45602	0.71	nc	0.71	nc
	45603	0.71	nc	0.71	nc
MPS A	45601	0	16.9	0	16.0
	45604	0	2.1	0	2.0
VEL	45820	11.8	nc	11.8	8.2
	45851	10.4	nc	10.4	8.8
VSR	45010	0.04	nc	0.04	0
	45030	0.01	nc	0.01	0
	45160	0.66	nc	0.66	0
SWIR	45250	26.4	nc	26.4	26.0
	45260	11.9	12.0	11.9	11.4
	45270	11.2	nc	11.2	8.4
	45280	32.3	nc	32.3	nc
	45301	0.084	nc	0.084	0
TIR	45513	27.6	31.9	27.6	nc
	45514	18.4	nc	18.4	nc
	45515	27.6	31.9	27.6	nc
	45530	0	1.09	0	nc
	45562	18.4	nc	18.4	nc
Total		253.8	250.7	253.8	227.2

nc = no change

ASTER Correlation Results

LOCKHEED MARTIN

CORRELATION RESULTS FROM
CASE 1 HOT2 BALANCE PLATEAU

GROUP # 19 19 TIR TLM

SENSOR DESCRIPTION	TEST	PREDICT	DELT P-T	FLAG
TT180 BLACKBODY	-4.0	-2.6	1.4	
TT181 TELESCOPE A	19.0	22.6	3.6	
TT182 SCANMOTOR A	2.0	-5.1	-7.1	*
TT183 RADIATOR	-7.0	-12.8	-5.8	*
TT184 BASEPLATE	19.0	23.8	4.8	
TT185 COOLER CTL A	25.0	24.7	-0.3	
TT186 1ST MIRROR	21.0	22.6	1.6	
TT187 2ND MIRROR	15.0	22.6	7.6	*
TT188 TELESCOPE B	17.0	22.6	5.6	*
TT189 LENS HOLDER	18.0	21.5	3.5	
TT190 CHOPPER MOTOR	17.0	24.7	7.7	*
TT191 AMP1	20.0	24.7	4.7	
TT192 AMP2	19.0	24.7	5.7	*
TT193 AMP3	19.0	24.7	5.7	*
TT194 AMP4	18.0	24.7	6.7	*
TT195 AMP5	20.0	24.7	4.7	
TT196 AMP6	20.0	24.7	4.7	
TT197 SIGPROCESR1	25.0	24.7	-0.3	
TT198 SIGPROCESR2	24.0	24.7	0.7	
TT199 STANDBY PS	24.0	24.7	0.7	
TT200 OPER PS	25.0	24.7	-0.3	
TT201 CLROUT1	23.0	23.8	0.8	
TT202 CLROUT2	23.0	23.8	0.8	
TT203 CLROUT3	24.0	24.5	0.5	
TT204 COOLER CTLR	24.0	24.7	0.7	
TT205 RADIATOR1	-21.0	-30.3	-9.3	*
TT206 RADIATOR2	-33.0	-37.9	-4.9	
TT207 SCAN CTLR 1	25.0	24.7	-0.3	
TT208 SCAN CTLR 2	25.0	24.7	-0.3	
TT209 SCAN MIRROR	1.0	-5.1	-6.1	*
TT210 SCAN MOTOR B	5.0	-5.1	-10.1	*
TT211 BLK BDY CTLR	22.0	24.7	2.7	

NUMBER OF VIOLATIONS = 11

STATISTICAL ANALYSIS

GROUP = ALL
AV DELTA = 0.9 STANDARD DEVIATION = 4.7

CORRELATION RESULTS FROM
CASE 2 COLD BALANCE PLATEAU

GROUP # 19 19 TIR TLM

SENSOR DESCRIPTION	TEST	PREDICT	DELT P-T	FLAG
TT180 BLACKBODY	-4.0	-2.6	1.4	
TT181 TELESCOPE A	19.0	20.6	1.6	
TT182 SCANMOTOR A	-5.0	-11.8	-6.8	*
TT183 RADIATOR	-8.0	-13.5	-5.5	*
TT184 BASEPLATE	19.0	23.2	4.2	
TT185 COOLER CTL A	24.0	23.5	-0.5	
TT186 1ST MIRROR	21.0	20.6	-0.4	
TT187 2ND MIRROR	15.0	20.6	5.6	*
TT188 TELESCOPE B	16.0	20.6	4.6	
TT189 LENS HOLDER	17.0	20.0	3.0	
TT190 CHOPPER MOTOR	15.0	23.5	8.5	*
TT191 AMP1	17.0	23.5	6.5	*
TT192 AMP2	16.0	23.5	7.5	*
TT193 AMP3	16.0	23.5	7.5	*
TT194 AMP4	16.0	23.5	7.5	*
TT195 AMP5	18.0	23.5	5.5	*
TT196 AMP6	19.0	23.5	4.5	
TT197 SIGPROCESR1	24.0	23.5	-0.5	
TT198 SIGPROCESR2	23.0	23.5	0.5	
TT199 STANDBY PS	23.0	23.5	0.5	
TT200 OPER PS	20.0	23.5	3.5	
TT201 CLROUT1	22.0	23.2	1.2	
TT202 CLROUT2	22.0	23.2	1.2	
TT203 CLROUT3	23.0	23.8	0.8	
TT204 COOLER CTLR	24.0	23.5	-0.5	
TT205 RADIATOR1	-21.0	-30.9	-9.9	*
TT206 RADIATOR2	-33.0	-38.3	-5.3	*
TT207 SCAN CTLR 1	19.0	23.5	4.5	
TT208 SCAN CTLR 2	19.0	23.5	4.5	
TT209 SCAN MIRROR	-5.0	-11.8	-6.8	*
TT210 SCAN MOTOR B	1.0	-11.8	-12.8	*
TT211 BLK BDY CTLR	21.0	23.5	2.5	

NUMBER OF VIOLATIONS = 13

STATISTICAL ANALYSIS

GROUP = ALL
AV DELTA = 1.2 STANDARD DEVIATION = 5.2

ASTER Correlation Results

LOCKHEED MARTIN

- SWIR Temperature Comparison Test/Predicts

CORRELATION RESULTS FROM
CASE 1 HOT2 BALANCE PLATEAU

GROUP # 18 18 SWIR TLM

SENSOR DESCRIPTION	TEST	PREDICT	DELT P-T	FLAG
TT150 COVER1B_PX	21.0	18.7	-2.3	
TT151 COVER2B_MX	18.0	18.8	0.8	
TT152 COVER3B_PZ	4.0	-8.7	-12.7	*
TT153 RADIATOR_B	20.0	14.7	-5.3	*
TT154 COLLECTOR1	19.0	19.5	0.5	
TT155 COLLECTOR2	23.0	19.5	-3.5	
TT156 AMP_DEWAR_A	29.0	19.5	-9.5	*
TT157 TLM_CMD_B	23.0	21.4	-1.6	
TT158 RADIATOR_A	26.0	24.5	-1.5	
TT159 COVER2A_MX	22.0	18.8	-3.2	
TT160 COVER1A_PX	24.0	18.7	-5.3	*
TT161 COVER3A_PZ	3.0	-8.7	-11.7	*
TT162 STRUCT	23.0	19.5	-3.5	
TT163 ELE_CIR1	23.0	21.4	-1.6	
TT164 ELE_CIR2	26.0	25.0	-1.0	
TT165 COMP_B	31.0	25.6	-5.4	*
TT166 FINGER_B	29.0	19.5	-9.5	*
TT167 AMP_DEWAR_B	29.0	19.5	-9.5	*
TT168 COMP_A	28.0	25.6	-2.4	
TT169 FINGER_A	29.0	19.5	-9.5	*
TT170 DRIVER	26.0	21.4	-4.6	
TT171 PROCESSOR	27.0	21.4	-5.6	*
TT172 TLM_CMD_A	31.0	21.4	-9.6	*
TT173 CAL	24.0	21.4	-2.6	

NUMBER OF VIOLATIONS = 11

STATISTICAL ANALYSIS

GROUP = ALL
AV DELTA = -5.0 STANDARD DEVIATION = 3.9

CORRELATION RESULTS FROM
CASE 2 COLD BALANCE PLATEAU

GROUP # 18 18 SWIR TLM

SENSOR DESCRIPTION	TEST	PREDICT	DELT P-T	FLAG
TT150 COVER1B_PX	23.0	18.1	-4.9	
TT151 COVER2B_MX	18.0	18.2	0.2	
TT152 COVER3B_PZ	2.0	-10.6	-12.6	*
TT153 RADIATOR_B	17.0	13.2	-3.8	
TT154 COLLECTOR1	18.0	19.0	1.0	
TT155 COLLECTOR2	22.0	19.0	-3.0	
TT156 AMP_DEWAR_A	27.0	19.0	-8.0	*
TT157 TLM_CMD_B	24.0	20.7	-3.3	
TT158 RADIATOR_A	23.0	24.0	1.0	
TT159 COVER2A_MX	23.0	18.2	-4.8	
TT160 COVER1A_PX	27.0	18.1	-8.9	*
TT161 COVER3A_PZ	1.0	-10.6	-11.6	*
TT162 STRUCT	23.0	19.0	-4.0	
TT163 ELE_CIR1	23.0	20.7	-2.3	
TT164 ELE_CIR2	25.0	24.9	-0.1	
TT165 COMP_B	31.0	25.5	-5.5	*
TT166 FINGER_B	26.0	19.0	-7.0	*
TT167 AMP_DEWAR_B	25.0	19.0	-6.0	*
TT168 COMP_A	27.0	25.5	-1.5	
TT169 FINGER_A	27.0	19.0	-8.0	*
TT170 DRIVER	23.0	20.7	-2.3	
TT171 PROCESSOR	23.0	20.7	-2.3	
TT172 TLM_CMD_A	29.0	20.7	-8.3	*
TT173 CAL	23.0	20.7	-2.3	

NUMBER OF VIOLATIONS = 9

STATISTICAL ANALYSIS

GROUP = ALL
AV DELTA = -4.5 STANDARD DEVIATION = 3.7

ASTER Correlation Results

LOCKHEED MARTIN

- MPS/CSP/VEL/VSR Temperature Comparison Test/Predicts

CORRELATION RESULTS FROM
CASE 1 HOT2 BALANCE PLATEAU

GROUP # 16 16 ASTER (NO TIR/SWIR) TLM

SENSOR DESCRIPTION	TEST	PREDICT	DELT P-T	FLAG
TT100 MPS PSC	7.0	8.5	1.5	
TT090 CSP HCE	6.0	10.8	4.8	
TT091 CSP PSU B/1	6.0	11.4	5.4	*
TT092 CSP PSU A/2	7.0	9.7	2.7	
TT093 CSP REF PT	5.0	9.0	4.0	
TT094 VSR_NADIR	18.9	23.3	4.4	
TT095 VSR_SCOPE(N)2	22.0	23.3	1.3	
TT096 VSR_SCOPE(N)1	3.0	16.7	13.7	*
TT097 VSR_BACKWARD	19.4	23.3	3.9	
TT098 VSR_SCOPE(B)2	22.0	23.3	1.3	
TT099 VSR_SCOPE(B)1	1.0	16.5	15.5	*
TT320 VSR_MOTOR	16.0	17.7	1.7	
TT321 VSR_SHAFT1	18.0	22.7	4.7	
TT322 VSR_SHAFT2	18.0	22.7	4.7	
TT323 VSR_ENCODER	15.9	20.5	4.6	
TT324 VSR_PREAMP1	7.0	14.5	7.5	*
TT325 VSR_PREAMP2	9.0	8.7	-0.3	
TT326 VSR_MONITORAMP	6.0	8.7	2.7	
TT327 VSR_LOCK	15.1	19.6	4.5	
TT328 VEL_VPS2/VSP2	4.0	15.6	11.6	*
TT329 VEL_VPS1/VSP1	4.0	15.6	11.6	*
TT330 VEL_VHC TEMP	4.0	15.6	11.6	*
TT331 VEL_VEL PLATE	5.0	15.6	10.6	*
TT332 VL_ELECTRORAD1	2.0	13.1	11.1	*
TT333 _VELRAIAT RAD2	2.0	12.9	10.9	*

NUMBER OF VIOLATIONS = 10

STATISTICAL ANALYSIS

GROUP = ALL
AV DELTA = 6.2 STANDARD DEVIATION = 4.5

CORRELATION RESULTS FROM
CASE 2 COLD BALANCE PLATEAU

GROUP # 16 16 ASTER (NO TIR/SWIR) TLM

SENSOR DESCRIPTION	TEST	PREDICT	DELT P-T	FLAG
TT100 MPS PSC	3.3	4.0	0.7	
TT090 CSP HCE	2.0	5.2	3.2	
TT091 CSP PSU B/1	2.0	5.8	3.8	
TT092 CSP PSU A/2	3.0	4.2	1.2	
TT093 CSP REF PT	1.0	3.5	2.5	
TT094 VSR_NADIR	19.2	23.3	4.1	
TT095 VSR_SCOPE(N)2	22.0	23.3	1.3	
TT096 VSR_SCOPE(N)1	1.0	16.2	15.2	*
TT097 VSR_BACKWARD	19.2	23.2	4.0	
TT098 VSR_SCOPE(B)2	22.0	23.2	1.2	
TT099 VSR_SCOPE(B)1	-2.0	15.9	17.9	*
TT320 VSR_MOTOR	17.0	17.4	0.4	
TT321 VSR_SHAFT1	18.0	22.6	4.6	
TT322 VSR_SHAFT2	19.0	22.6	3.6	
TT323 VSR_ENCODER	15.9	20.4	4.5	
TT324 VSR_PREAMP1	3.0	7.7	4.7	
TT325 VSR_PREAMP2	5.0	7.7	2.7	
TT326 VSR_MONITORAMP	5.0	7.7	2.7	
TT327 VSR_LOCK	15.1	19.2	4.1	
TT328 VEL_VPS2/VSP2	-2.0	4.9	6.9	*
TT329 VEL_VPS1/VSP1	-3.0	4.9	7.9	*
TT330 VEL_VHC TEMP	-2.0	4.9	6.9	*
TT331 VEL_VEL PLATE	-1.0	4.9	5.9	*
TT332 VL_ELECTRORAD1	-5.0	2.7	7.7	*
TT333 _VELRAIAT RAD2	-4.0	2.6	6.6	*

NUMBER OF VIOLATIONS = 8

STATISTICAL ANALYSIS

GROUP = ALL
AV DELTA = 5.0 STANDARD DEVIATION = 4.1

ASTER Correlation Results

LOCKHEED MARTIN

- Power Balance (W)

	Measured Orbit Average		Model	Pre-Test Model		Post Test Model Component Dissipation [1]		Post Test Model Heater Estimate	
Instrument	Hot TB	Cold TB	Jun-96	TB.hot	TB.cold	TB.hot	TB.cold	TB.hot	TB.cold
ASTER	274.6	254.7		253.8	253.8	250.7	227.2	32.6	36.3
TIR [2]				81.9	81.9	82.0	78.1	6.7	7.0
SWIR [2]				92.0	92.0	101.7	92.0	7.6	10.0
CSP [2]				24.6	24.6	23.7 [3]	20.7 [3]	0	0
MPS [2]				32.4	32.4	21.4 [3]	19.4 [3]	0	0
VEL [2]				22.2	22.2	22.2	17.0	0	0
VSR [2]				0.7	0.7	0.7	0	18.4	20.8

Note 1 Does not contain heater power estimate, i.e., to calculate total power in model, add the corresponding "Dissipation" and "Heater Estimate" columns.
Note 2 Broken out seperately (included in ASTER totals)
Note 3 Measured directly from telemetried current

- Discussion of Results
  - ASTER TIR: Overall, good agreement between model and test has been achieved:
    - – Hot TB : Mean $\Delta T = +0.9\ ^0C$, standard deviation $< 5\ ^0C$
    - – Cold TB: Mean $\Delta T = +1.2\ ^0C$, standard deviation 5.2 ^0C
    - – Instrumentor satisfied with results : see response in Attachment 3
  - ASTER SWIR: High mean deviation values require further study by Instrumenter (check RTM and detailed ASTER thermal models) :
    - – Hot TB : Mean $\Delta T = -5.0\ ^0C$, standard deviation $< 4^0C$
    - – Cold TB: Mean $\Delta T = -4.5\ ^0C$, standard deviation $< 4\ ^0C$
    - – Good standard deviation. High mean deviation indicating that the Instrumenter should evaluate (provided) impressed dissipation (too low?) and/or model inconsistencies.
    - – Instrumentor satisfied with results : see response in Attachment 3

ASTER Correlation Results

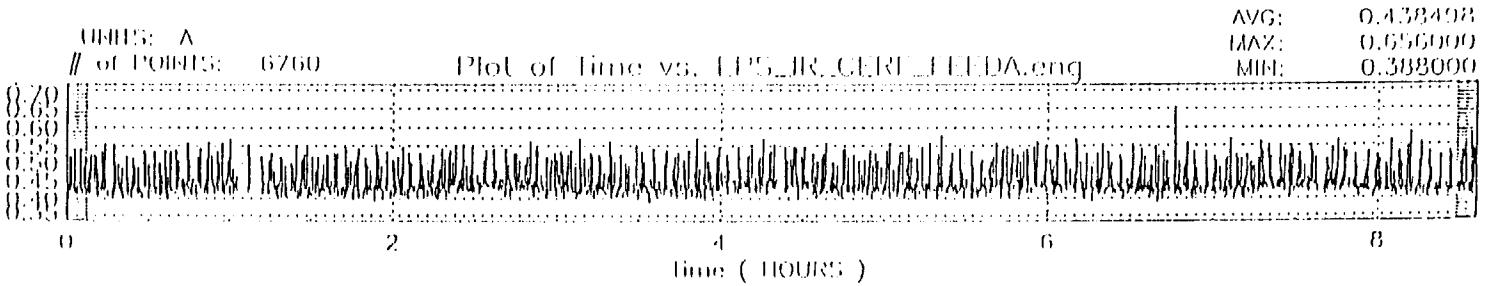
LOCKHEED MARTIN

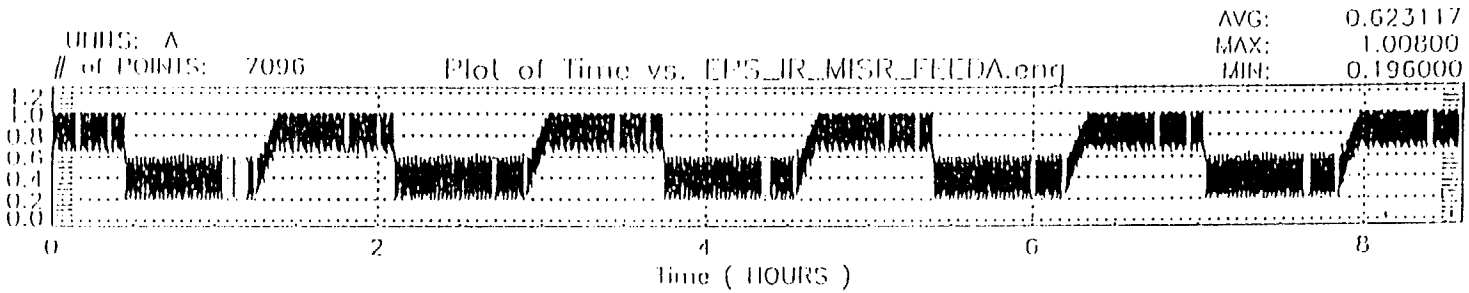
- Other ASTER components: Mixed results requiring further study by Instrumenter (check RTM and detailed ASTER thermal models):
  - Hot TB : Mean $\Delta T = +6.2\ ^0C$, standard deviation $< 5^0C$
  - Cold TB: Mean $\Delta T = +5.0\ ^0C$, standard deviation $< 5\ ^0C$
  - MPS, CSP & VSR predicts appear to agree fairly well with test values, with the exception of 2 VSR Scope nodes. VEL temperature predicts are on average 10^0C warmer than test. Instrumenter should evaluate should evaluate impressed dissipation and/or model inconsistencies.
- The impressed dissipation and estimated heater power exceeds the measured power by 8.7 W in Hot TB and 4.9 W in the Cold TB. This is higher than we would like, and indicates that some changes may be required to the (instrument–provided) impressed dissipations
- In the ASTER SWIR RTM, 3 of the 5 heaters are not modelled. Further discussion with the Instrumenter is required to resolve the impact of these heaters.

Good agreement with parts of ASTER model achieved. Instrumenter generally satisfied with the results

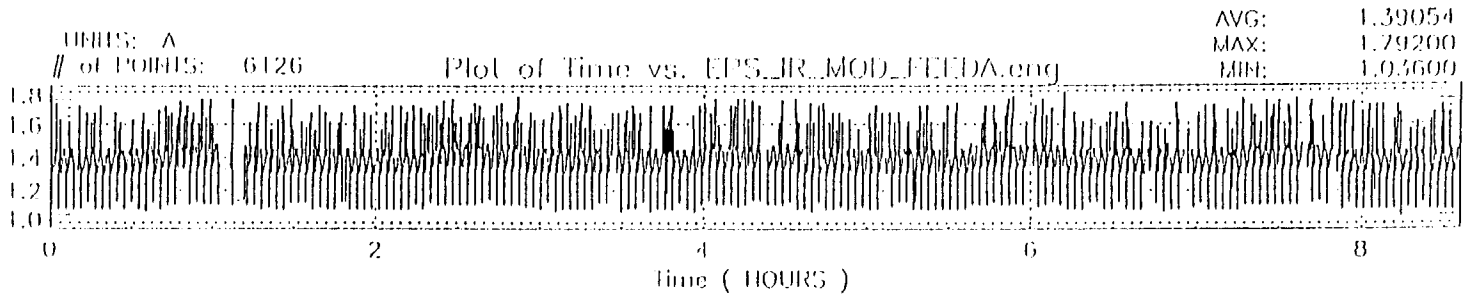
Instrument Current Telemetry Data

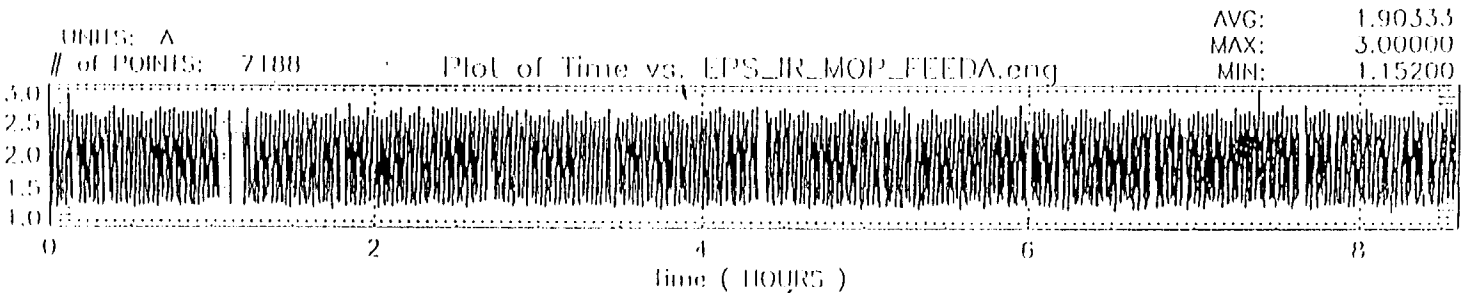
LOCKHEED MARTIN





Hot TB



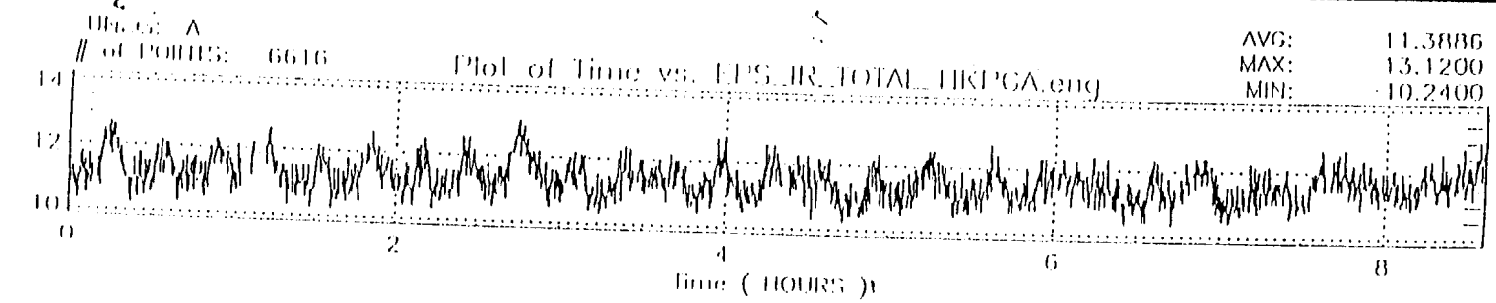


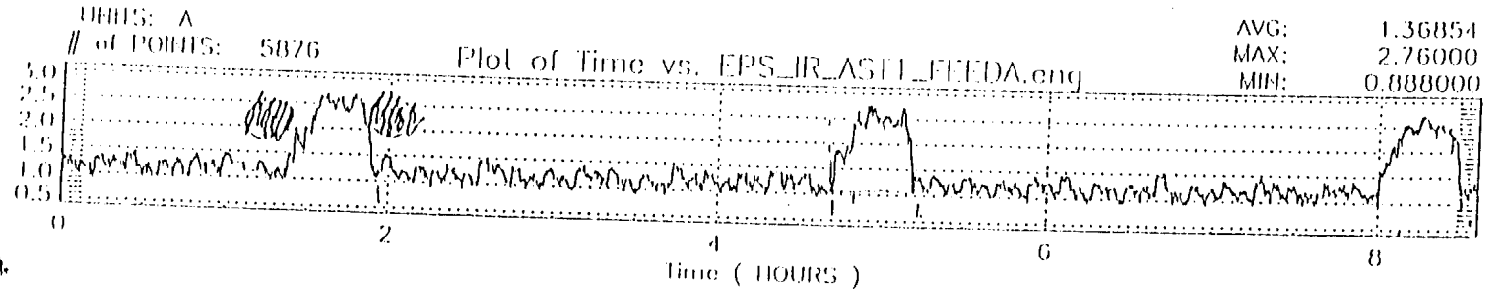
Starting Ground Time: 038/1998 20:00:05.000
Starting Sys. Time: 181/1998 22:06:52.896

Plot Timespan:
Feb 07 20:00:00 thru Feb 08 04:36:0

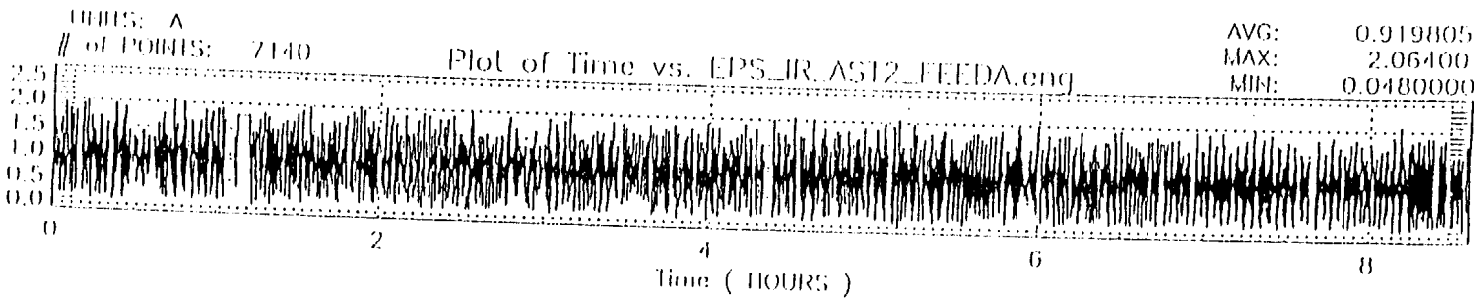
Instrument Current Telemetry Data

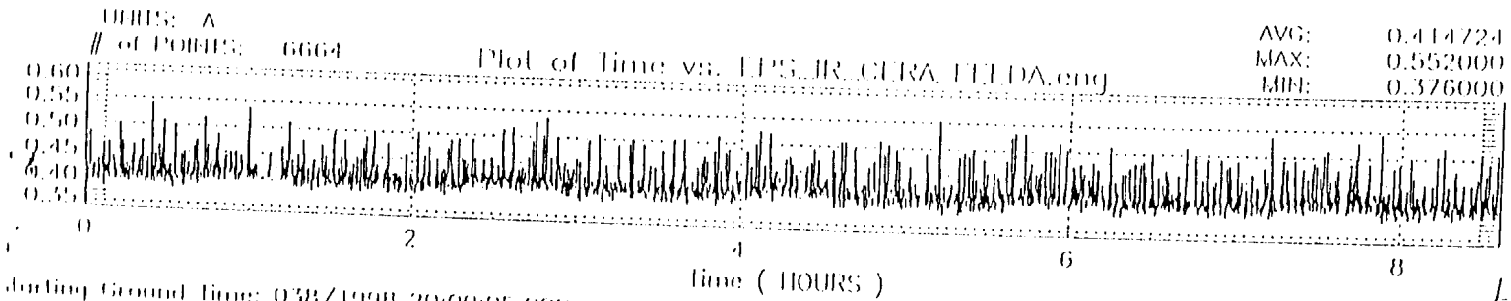
LOCKHEED MARTIN





Hot TB



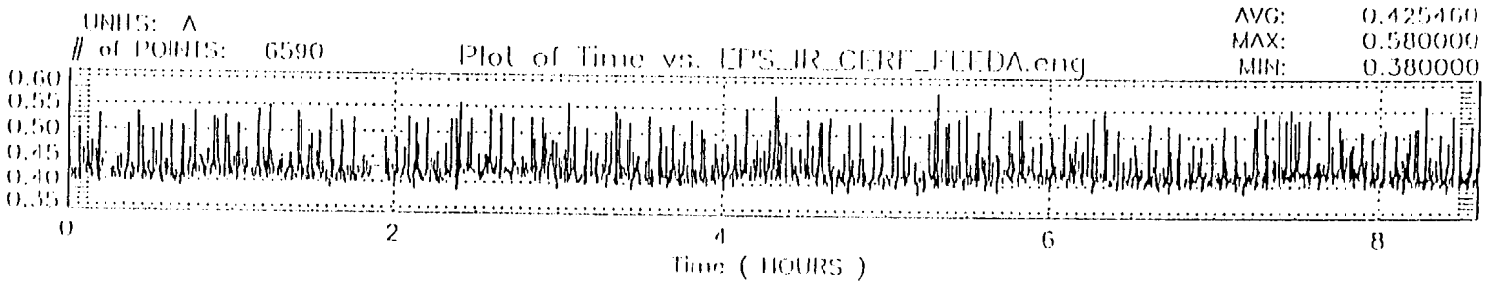


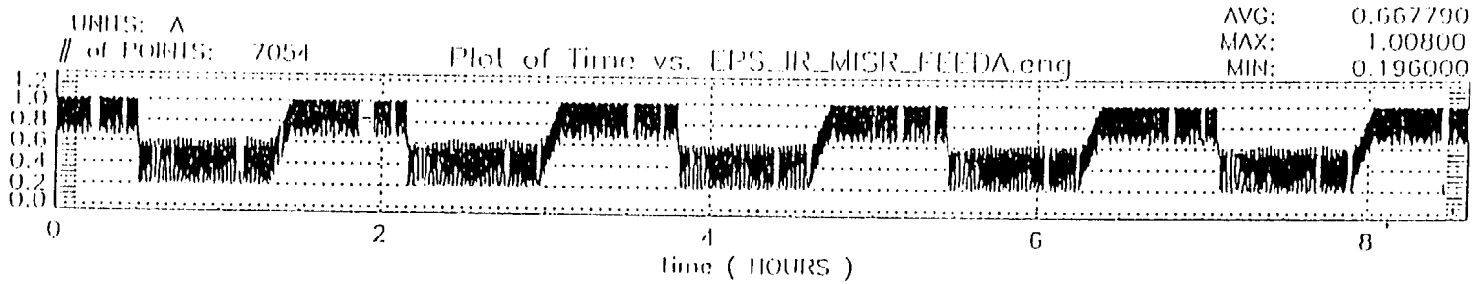
Starting Ground Time: 038/1998 20:00:05.000
Starting S/C Time: 181/1998 22:06:53.008

Plot Timespan:
Feb 07 20:00:00 thru Feb 08 04:36:00

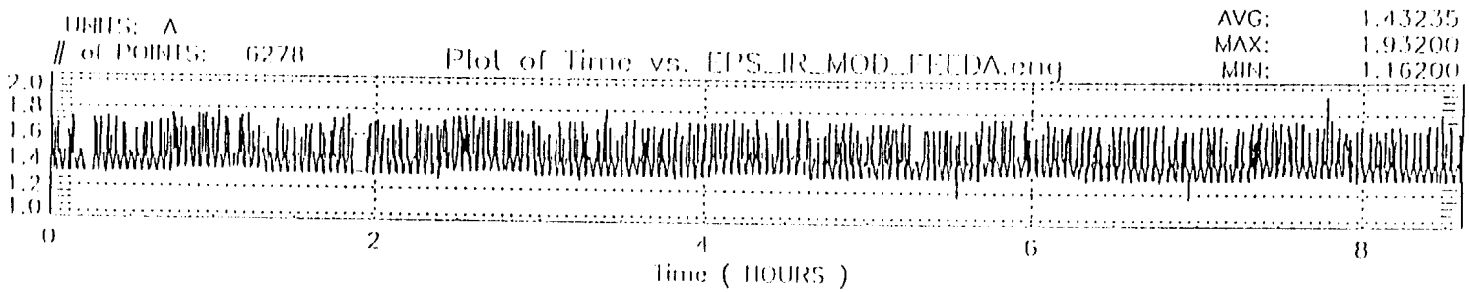
Instrument Current Telemetry Data

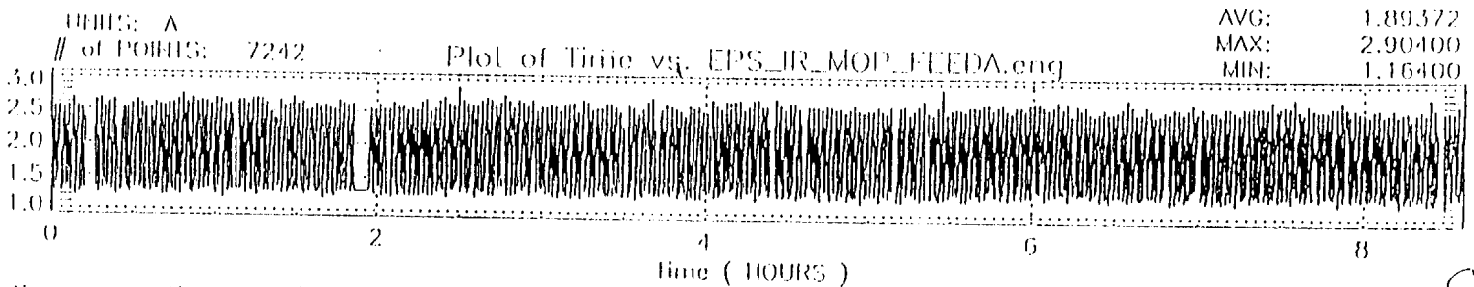
LOCKHEED MARTIN





Cold TB



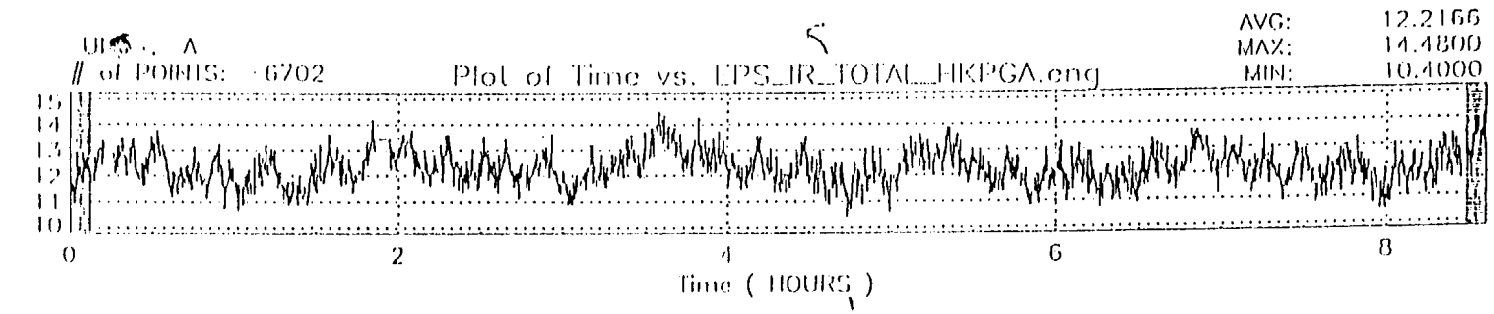


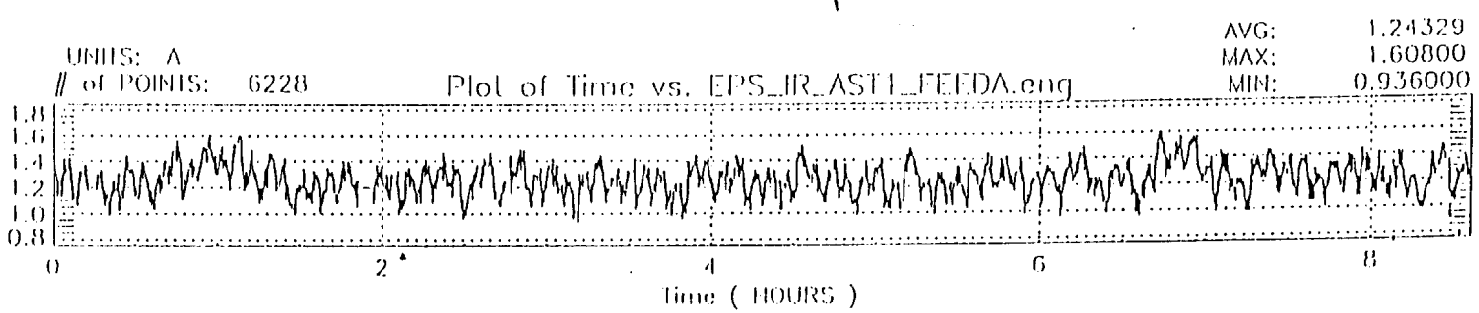
Starting Ground Time: 040/1998 20:00:06.000
Starting S/C Time: 182/1998 22:45:51.712

Plot Timespan:
Feb 09 20:00:00 thru Feb 10 04:36.00

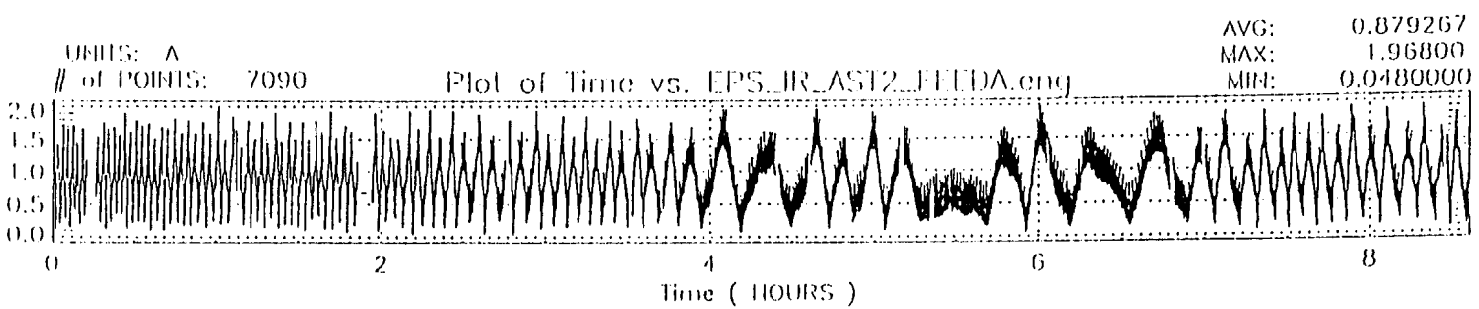
Instrument Current Telemetry Data

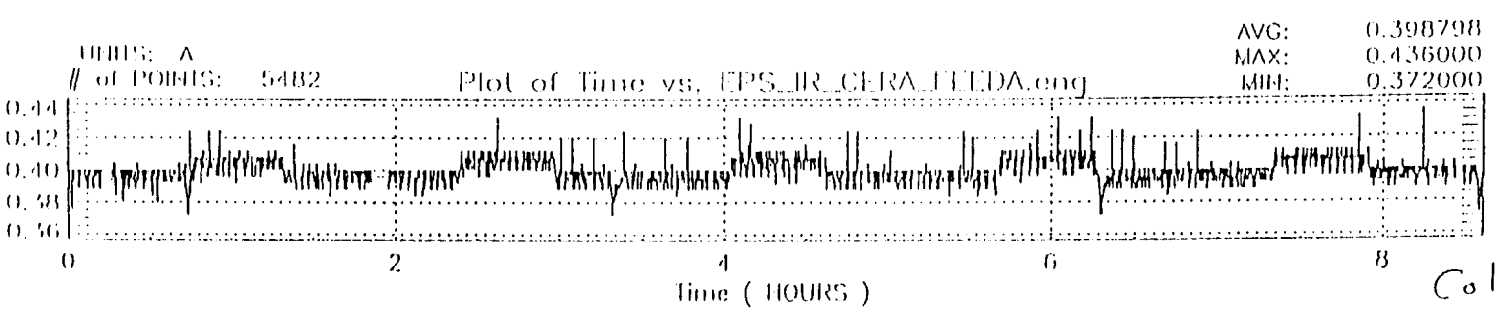
LOCKHEED MARTIN





Cold
TB





Cold

Starting Ground Time: 040/1998 20:00:06.000
Starting S/C Time: 182/1998 22:45:51.824

Plot Timespan:
Feb 09 20:00:00 thru Feb 10 04:36:00

Introduction

TB Test Overview

Post–Test Activities

Thermal Model Correlation Results

TCS Hardware Performance Review

Conclusions/Recommendations

Conclusions & Recommendations

LOCKHEED MARTIN

- EOS–AM S/C Thermal Balance Test successful in verifying S/C TMM
- Correlation goals for the most part met
- No major S/C TMM changes indicated
- Hardware impacts limitted to additional MLI on Propulsion Module Lines.
- Instrument RTMs for CERES, MISR and MOPITT appear in good shape
- Feedback from Instrumentor required on:
  - ASTER: Uncertainty on heater operation on SWIR. Further discussions with Instrumenter will be held to resolve open issues.
  - MODIS: Power #'s do not appear to balance. Further discussions with Instrumenter will be held to resolve open issues.
- Proper TCS hardware performance verified, except for;
  - Minor CPHTS operational issues were identified and will be fixed for flight
  - HCE–2A anomaly (heater on/off status) which will not impact on–orbit operations (see EOS–TH–898)
  - HCE–5A anomaly (Battery voltage monitoring) which will not impact on–orbit operations (see EOS–PWR–556A)
- All test data and photographs on file at LMMS and available for quick turn–around review
- Based on the successful conclusion of the test correlation, the next phase in the process (update S/C flight predicts) is ready to begin.

Correlation of TCS TMM successfully completed, and TCS performance successfully demonstrated during S/C TV/TB Testing

GSFC: Goddard Space Flight Center
Greenbelt, MD 20771

K.	Anderson	Code 421
W.L.	Barnes	Code 970
J.	Gervin	Code 421
B.	Guenther	Code 920.1
E.	Knight	RDC/Code 920.1
R.	Kozon	Code 505
K.	Parker	RDC/Code 920.1
V.	Salomonson	Code 900
R.	Taylor	Code 421
A.	Unger	Code 421
D.	Wood	Code 421
EOS Library (2)		86/104

LMSMS: Lockheed Martin Space Mission Systems
1616A McCormick Drive
Landover, MD 20785

N. Kureishy
N. Pingitore

COM DEV: COM DEV
155 Sheldon Dr.
Cambridge, Ontario N1R 7H6
CANADA

D. Caldwell
R. Deschambault
T. Girard
J. Hackett
D. Henry

CSA: Canadian Space Agency
100 Sussex Dr.
Ottawa, Ontario
CANADA

R. Colley
D. Peterson

UofT: University of Toronto
Department of Physics
60 St. George Street
Toronto, Ontario M5S 1A7
CANADA

G.	Bailak	Rm 704
M.	Butler	Rm 704
J.	Drummond	Rm 616

NCAR: National Center for Atmospheric Research
1850 Table Mesa Drive
Boulder, CO 80303

P. Bailey

SBRS: Raytheon Santa Barbara Remote Sensing
75 Coromar Drive
Goleta, CA 93117

R.	Durham	B32/MS 79
D.	LaKomski	B32/MS 79
J.	Mehrten	B32/MS 79
N.	Therrien	B32/MS 79